Volume 22, Number 6, March 31, 1968

NUCLEAR SCIENCE ABSTRACTS

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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    21:8905(R) (AD-631189)
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SHELTERS
  construction of, for civil defense,  21:8838
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  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
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  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
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  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 10549, 10575, 10622, 10638, 10706, 10782, 10974, 11041, and 11948.

10170 (CEA-R-3284) DETERMINATION DE LA RADIOACTIVITE DE L'EAU DE MER EN RUTHENIUM, CERIUM, ZIRCONIUM PAR ENTRAINEMENT ET ADSORPTION AU MOYEN DU BIOXYDE DE MANGANESE. (Determination of the Ruthenium, Cerium, and Zirconium Radioactivity of Sea-Water by Carrying-Over and Adsorption Using Manganese Dioxide). Gueguenlat, Pierre (Commissariat a l'Energie Atomique, la Hague (France)). July 1967. 29p. (In French). Dep.

Manganese dioxide is precipitated in the medium to be analyzed by the action of hydrogen peroxide on potassium permanganate. Large volumes of seawater are treated by successive adsorptions of 80 liter fractions always using the same precipitate obtained from 30 g of potassium permanganate. Some examples are given concerning the analysis of 80, 160, 1000 and 2000 liters of water. The existence of low activities due to ruthenium, zirconium, and cerium can be demonstrated if sufficiently large volumes of water are treated. (auth)

10171 (CNEA-192) DETERMINACION DE URANIO CON UN TITULADOR CULOMBIMETRICO A POTENCIAL CONTROLADO. (Determination of Uranium With a Potential-Controlled Coulometric Titrator). Krause, Walter J.; Dupetit, G. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1967. 24p. (In Spanish). Dep.

The determination of uranium in the 2- to 20-mg/sample range with a controlled-potential coulometric titrator was studied for the subsequent determination and control of the uranium concentration in solutions arising from the various phases in the irradiated fuel reprocessing plant. The method can be used in the presence of aluminum and nitric acid in relatively large amounts and in the presence of small quantities of Fe(III) and Hg(II). The determination is based on the U(VI)–U(IV) reduction in a controlled-potential mercury cathode cell, using 1M sulfuric acid as supporting electrolyte. The reduction mean time oscillates between 12 and 18 min and the results agree within a standard deviation of 0.1 to 0.8%. A general outline for electric calibration of the titrator is given. (auth)

10172 (LA-3781) SPECTROPHOTOMETRIC DETERMINATION OF MICROGRAM QUANTITIES OF IRON IN PLUTONIUM METAL AND ALLOYS. Marshall, Thomas K.; Dahlby, Joel W.; Waterbury, Glenn R. (Los Alamos Scientific Lab., N. Mex.). Aug. 1, 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Iron, when present in concentrations between 0.35 and 30 ppM in electrorefined plutonium metal and its alloys or salts, was measured spectrophotometrically as ferrous orthophenanthrolate following separation by liquid–liquid extraction. In the separation, iron(III) was extracted from an 8N hydrochloric acid solution of the plutonium into a dichloroethyl ether–carbon tetrachloride mixture. Then the iron was reduced and back-extracted into an aqueous phase containing hydroxylamine hydrochloride, sodium acetate buffer, and o-phenanthroline. The absorbance of the iron(II)-o-phenanthrolate was measured at 510 mμ. Based on 12 to 16 determinations each of 0.35, 0.696, 3.48, 6.96, 10.5, and 13.9 ppM of iron in plutonium, the relative standard deviations of the method were found to be 13.0, 11.7, 0.76, 0.37, 0.25, and 0.47%, respectively. From these data, a molar absorptivity of 10,700 was calculated. Of 54 ions tested, only antimony, gallium, silicon, and thallium interfered. Gallium, which is the only one of these elements often found in plutonium, can be eliminated by a pre-extraction step. (auth)

10173 (ORNL-TM-2108) SPECTROPHOTOMETRIC DETERMINATION OF TOTAL PLUTONIUM: OBSERVATIONS ON THE REACTIONS BETWEEN ARSENAZO AND Pu(III), Pu(IV), AND Pu(VI). Guyon, John C.; Stokely, J. R.; Shults, W. D. (Oak Ridge National Lab., Tenn.). Jan. 2, 1968. Contract W-7405-eng-26. 13p. Dep. CFSTI.

A spectrophotometric method for total plutonium in the microgram range is presented. The method is based on the reaction of Pu(IV) with Arsenazo in moderately acidic solution. The method is rapid, selective, and sensitive yielding a linear calibration curve and giving a molar absorptivity at 575 nm of 25,900. Preliminary studies on the reactions of Pu(III), Pu(IV), and Pu(VI) with Arsenazo are presented. Suggestions are made for the development of a method for the determination of the concentrations of each oxidation state in any possible mixture of the three. (auth)

10174 (PG-Report-290(Rev.)) ANALYTICAL METHOD FOR THE DETERMINATION OF PLUTONIUM IN PLUTONIUM METAL. (DIFFERENTIAL SPECTROPHOTOMETRY). (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1968. 6p. Dep. CFSTI. UK.

A solution of plutonium metal in hydrochloric acid was maintained in the trivalent state with hydroxylamine hydrochloride, and the relative absorbancy of the solution measured at 561 mμ against a plutonium reference standard. The precision was three times standard deviation ± .20% based on more than 100 routine determinations. (auth)

10175 (LB/G-2584) CONSIDERATIONS IN SELECTING A METHOD FOR DETERMINING TRACE CONSTITUENTS. Schueller, H. Translated by E. F. Towndrow for Atomic Energy Research Establishment, Harwell, Eng., from Mikrochim. Acta, No. 4/5, 742-50(1966). 10p. (CONF-650992-1). Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

From Symposium on Analytical Chemistry, Graz, Austria.

In the determination of substances that are present in very small amounts it is primarily necessary to find the errors of the individual steps in the analysis. The greatest partial error governs the total error of the method and is usually due to the heterogeneity of the material being examined. Only with a knowledge of the total error can a decision be reached as to whether the analysis has informational value and what apparatus is necessary. The concepts error, precision, and accuracy are defined and examples are considered. (auth)

10176 (UCRL-Trans-10184) HIGH-RESOLUTION QUALITATIVE ANALYSIS BY FILTERED ELECTRONIC IMAGES. PART I. El Hili, A. Translated by W. G. Robinson for Univ. of California Lawrence Radiation Lab., Livermore, from J. Microscop., 5: 669-90(1966). 38p. Dep. CFSTI. JCL $3.60 fs, $1.37 mf.

Utilization for the formation of electron microscope images of only those electrons that have suffered a discrete and characteristic energy loss reveals the local distribution of a given constituent in the observed region. This method of qualitative microanalysis allows the identification of phases of very small dimensions, of the order of 100Å. The possibilities of this technique are related both to the dispersive system used and to the characteristics of the energy-loss spectrum of the constituents being analysed. (auth)

10177 BETA-PARTICLE RECOIL METHOD FOR DETERMINING LEAD IN ROCK. Hudec, Imrich (Mining Inst., Prague). Jad. Energ., 13: 472-3(1967). (In Czech).

A beta-particle recoil field method for determining lead content in dolomite rock bearing also zinc, copper, or iron is described. (R.V.J.)

10178 QUANTITATIVE DETERMINATION OF POTASSIUM BY NATURAL RADIOACTIVITY. Knudson, George E. (Luther Coll., Decorah, Iowa). J. Chem. Educ., 44: 694(Nov. 1967).

Simplified techniques are presented for the quantitative determination of K by means of its natural radioactivity. Naturally occurring potassium contains 0.012% of ^{40}K, most of which decays by emission of 1.32-MeV β particles and the remainder (13%) by emission of 1.46-MeV γ radiation. The β particles are easily detected by a thin-window G-M tube, but are absorbed to a considerable extent by the sample itself when the sample is thick enough to give high counting rates. Potassium chloride is a convenient standard since it contains a higher percentage of K than other common K salts. A self-absorption curve may be prepared by measuring the activity of samples varying in thickness from 0 to 0.3 g/cm^2. The technique described employs 2-g samples in 32-mm dia Cu planchets, with a sample thickness of 0.124 g/cm^2. Precision of the method is limited by the stability of the counting systems over the time interval required for the measurements. (BBB)

10179 USE OF CHARGED PARTICLES ASSOCIATED WITH NEUTRON-INDUCED REACTIONS FOR DETERMINING THE ISOTOPIC COMPOSITION OF BORON, LITHIUM, AND HYDROGEN. Plaksin, I. N.; Dzhemard'yan, Yu. A.; Malysheva, N. G.; Starchik, L. P. Radiokhimiya, 9: 501-4(1967). (In Russian).

The isotopic composition of lithium and boron was determined in solid Li_2CO_3 and H_3BO_3 by using the following reactions ^6Li $(n,\alpha)^3H$ + 4.78 MeV = 945 barn/atom; and ^{10}B $(n,\alpha)^7Li$ + 2.78 MeV = 4010 barn/atom. A polonium–beryllium source with an activity of 0.25 Ci was used to obtain the flux of thermal neutrons. The determination of the isotopic composition of lithium and boron lasted 20 to 25 min with a relative error of 5 to 7% for 8 to 15% lithium-6. The isotopic composition of hydrogen was also determined by using the (n,p) reaction–the scattering of neutrons by hydrogen in the mixture H_2O + D_2O. The determination lasted 15 to 20 min, and the relative square error for 1% H_2O for a neutron source activity of 1 Ci was 3 to 4%. (ATD)

10180 SUBSTOICHIOMETRIC, EXTRACTION–RADIOMETRIC DETERMINATION OF MICROQUANTITIES OF URANIUM BY THE ISOTOPIC DILUTION METHOD. Grashchenko, S. M.; Sobotovich, E. V. Radiokhimiya, 9: 412-18(1967). (In Russian).

An attempt was made to extend the scope of application of the substoichiometric extractive-radiometric isotope dilution method to the range of microconcentrations, where the dissociation of the complex being extracted has a substantial effect. A technique was worked out for determining microgram quantities of uranium (VI), uranium-233 being used as the radioactive tracer, and Arsenazo III as the complex-forming reagent. The organic phase was thenoyltrifluoroacetone in chloroform. It was found that the sensitivity of the extractive-radiometric method can be increased by establishing the dependence of the amount of element separated in the aqueous phase on its concentration in the organic phase for given substoichiometric conditions of extraction. This principle can be extended to the analysis of many other elements by such a method. Knowledge of this dependence also considerably broadens the assortment of extracting agents that are suitable for substoichiometric determination, and this permits the analysis of elements for which it is difficult to find suitable complex forming agents, as in the case of uranium. (ATD)

10181 BURNUP DETERMINATION BY γ SPECTROMETRY AT ZERO POWER EXPERIMENTS. Knoth, J.; Marten, R.; Schwenke, H. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht Ger.). Atomkernenergie, 13: 67-71(1968). (In German).

For a bundle of 9 fuel rods irradiated in a zero-power experiment at 30 watts-hr corresponding to a burnup of about 5×10^{-8}%, the burnup distribution was determinated by means of γ spectrometry of fission products. The self-absorption within the fuel rod was calculated. Nineteen γ-peaks within an energy range from 230 to 1600 keV were considered. The accuracy of the absolute determination was about 2%. The spectra were evaluated automatically by an Algol-program on a CDC 3400. (auth)

10182 IMPROVED DETERMINATION OF MICROGRAM AMOUNTS OF LEAD IN FOOD WITH A RADIOACTIVE TRACER. Bogen, Donald C.; Kleinman, Michael T. (Atomic Energy Commission, New York). Analyst, 92: 611-13(1967).

In the method described, microgram amounts of lead in food are determined by use of a radioactive tracer. The tracer, lead-212, is radiochemically purified from thorium nitrate and is used for chemical yield determination. Food sample dissolution involves freeze drying and wet ashing to minimize contamination and eliminate volatilization. The stable lead is determined spectrophotometrically as the dithizone complex at 510 mμ. The chemical recovery for analysis is 94%, and the precision of analysis is better than 10%. (auth) (UK)

10183 QUANTITATIVE PAPER CHROMATOGRAPHY OF INACTIVE SUBSTANCES BY RADIOACTIVE ADDITIVES. I. Ackermann, Gerhard; Weber, Egon (Bergakademie, Freiberg, Ger.). Talanta, 15: 63-71(Jan. 1968). (In German).

A radiometric method for determination of inactive sulphate or thiosulphate on paper chromatograms is described, based on the addition, in each determination, of a constant quantity of active sulphate or thiosulphate, respectively. With active, carrier-free, sulphuric acid, a relative standard deviation of 4.6% was obtained, but this could be improved to 3.5% by statistical manipulation on a computer. (auth) (UK)

10184 TRACE ELEMENTS IN THE LUNG. Molokhia, Mohamed M.; Smith, Hamilton (Univ. of Glasgow). Arch. Environ. Health, 15: 745-50(Dec. 1967).

Radioactivation methods were used to determine the trace elements Sb, As, Cd, Cu, Mn, Hg, and Zn in the lungs. (M.C.G.)

10185 SIMULTANEOUS DETERMINATION OF ^{90}Sr, ^{137}Cs, AND ^{144}Ce IN SEAWATER. Ivanova, L. M. Radiokhimiya, 9: 622-33(1967). (In Russian).

The solubility of mixed cesium ferrocyanides with calcium and magnesium was determined. The solubility of $Cs_2Ca[Fe(CN)_6]$ was 3.5 ± 0.4 and $4.0 \pm 0.5 \times 10^{-5}$ moles/liter at 25°C in water and seawater (S = 36.63‰), respectively, and that of $Cs_2Mg[Fe(CN)_6]$ was 3.0 ± 0.5 and 3.5 ± 0.5, respectively. With increasing concentrations of KCl, NaCl, and Na_2CO_3 the solubility of the mixed cesium ferrocyanides increases, especially that of $Cs_2Ca[Fe(CN)_6]$. The introduction of $K_4[Fe(CN)_6]$ to 0.006M reduces the solubility of $Cs_2Mg[Fe(CN)_6]$ to $1.1 \pm 0.5 \times 10^{-5}$ moles/liter. Under those conditions bringing the Na_2CO_3 concentration to 0.133M and NH_4Cl to 0.112M does not substantially increase the solubility of the cesium magnesium ferrocyanide. A method of joint concentration of radioactive cesium, strontium, and cerium from seawater was worked out on the basis of the above determinations and is described. (JPRS)

10186 ISOTOPIC-DILUTION ANALYSIS WITH A MODIFIED SUBSTOICHEIOMETRIC RESIDUE METHOD FOR CARBONATE AND SULPHATE. Johannesson, J. K. (Auckland Technical Inst., New Zealand). Analyst, 92: 766-8(Dec. 1967).

A new modification of the substoicheiometric isotopic-dilution method is presented. After the addition of a standard amount of labelled compound, the isotopically diluted compound was then isolated as a residue of constant weight, and the beta activity measured. The method as applied to the determination of sulphate and carbonate is applicable in the range 10 to 100 μg for these anions. (auth) (UK)

10187 COULOMETRIC TITRATION WITH MOLYBDENUM(V) FOR DETERMINATION OF CERIUM, CHROMIUM, AND VANADIUM. Yen, Hui-yu; Jen, Hung-tei. K'o Hsueh T'ung Pao, 17: 28-31(Jan. 15, 1966).

The use of electrolytically generated pentavalent Mo as a reductant for coulometric titration is reported and applied to the determination of Ce(IV). The current efficiency for electrogeneration of Mo(V) at a Pt cathode in sulfuric acid media was evaluated as a function of the generating current density and concentration of Mo(VI) in various concentrations of sulfuric acid. Cerium (IV), V(V), and Cr(VI) were titrated in a supporting electrolyte composed of 4.5M sulfuric acid and 0.1M ammonium molybdate. A modified potentiometric method was used for end-point detection, using a Pt indicator electrode and saturated calomel reference electrode. The generator cathode was of Pt foil, and the anode was a Pt wire in 3M sulfuric acid contained in a glass tube, the bottom of which was closed by a sintered glass disk, immersed in the test solution. Titrations could be performed in the presence of oxygen. The results demonstrated that quantities of Cr(VI) from about 0.5 to 2.5 mg, V(V) from about 1 to 2.5 mg, and Ce(VI) about 12 mg in a volume of about 30 to 40 ml could be titrated with an average error of < 0.2%. (BBB)

10188 EXTRACTION OF CHROMATOGRAPHICALLY ISOLATED FATTY ACIDS FROM LIQUID SCINTILLATION FLUID. Howard, Charles F. Jr.; Kittinger, George W. (Oregon Regional Primate Research Center, Beaverton). Lipids, 2: 438-9(Sept. 1967).

A method was devised by which an individual fatty acid, isotopically labeled, could be recovered from the scintillation fluid after it had been separated as a methyl ester by gas-liquid chromatography and trapped for radioassay. The 1-^{14}C-palmitic acid, 16-^{14}C-palmitic acid, and 1-^{14}C-linoleic acid used to establish the procedure were diluted with nonradioactive palmitic or linoleic acid and methylated with diazomethane. The scintillation fluid (5 g 2,5-diphenyloxazone and 0.3 g p-bis[2-(5-phenyloxazolyl)]-benzene per liter of toluene) served to trap the fatty acid. After counting, 12 ml of the fluid and 12 ml of 2.5% KOH in 95% ethanol were mixed, and this 1-phase system was heated at 37°C for 120 min. Five ml of distilled water was added, the contents were mixed on a Vortex mixer and centrifuged to separate the 2 phases. The top layer (scintillation fluid) was aspirated, and the lower aqueous layer was extracted one time with 10 ml of toluene and 3 times with 10-ml aliquots of redistilled petroleum ether (bp 40 to 49°C). The aqueous phase was extracted 3 times with 10-ml aliquots of petroleum ether; the resulting extract accounted for about 94% of the fatty acids initially radioassayed. (BBB)

10189 OXYGEN ISOTOPIC COMPOSITION OF SULFATES. PART I. A METHOD FOR THE EXTRACTION OF OXYGEN AND ITS QUANTITATIVE CONVERSION TO CARBON DIOXIDE FOR ISOTOPE RADIATION MEASUREMENTS. **Rafter, T. A. (Inst. of Nuclear Sciences, Lower Hutt, N. Z.). N. Z. J. Sci., 10: 493-510(June 1967).**

The graphite reduction method was used for the recovery of S from sulfates as SO_2 for S isotope ratio studies was modified for recovering oxygen as CO_2 for oxygen isotope ratio studies in sulfates. In the reduction process a small percentage of the oxygen is evolved as CO. By use of an electrical discharge this gas can be converted to CO_2 by the reaction $2CO \rightarrow CO_2 + C$. The recovery of oxygen as CO_2 from $BaSO_4$ is quantitative and the reproducibility of the oxygen isotope measurement (±0.3‰) good. Preliminary studies showed the stability of the SO_4^{2-} under normal precipitation conditions but recovery of SO_4 after Na_2CO_3 fusion is at present suspect to oxygen exchange. The oxygen isotope ratios in numerous sulfates were examined and found to cover a range of +2 to +14‰ per mil with respect to standard mean ocean water (SMOW). The isotopic geochemical significance of such variations are being investigated. (BBB)

10190 THE COORDINATION CHEMISTRY OF THE ACTINIDE HALIDES. **Bagnall, K. W. (Atomic Energy Research Establishment, Harwell, Eng.). Coord. Chem. Rev., 2: 145-62 (Sept. 1967).**

This review, with 225 references, provides a general survey of this field as well as of the following specific substances: the tervalent actinides (trihalides, oxyhalides, and complexes); the tetravalent actinides (tetrahalides, oxyhalides, halocomplexes, oxygen donor complexes, nitrogen donor complexes, sulfur donor complexes, and cyclopentadienylhalides); the pentavalent actinides (pentahalides, oxyhalides, halocomplexes, oxygen donor complexes, and nitrogen donor complexes); and the hexavalent actinides (hexahalides, halocomplexes, oxyhalides, oxyhalocomplexes, complexes of the oxyhalides with oxygen donors, and complexes of the oxyhalides with nitrogen donors). The review includes the stereochemistry of the halides themselves but structural data are lacking for almost every donor complex recorded here. The earlier members of the actinide group, up to Am, exhibit a greater variety of valence states than the higher actinides, which appear to be predominantly lanthanide in character, but very little is known about the complexing properties of any of the tervalent actinides. The actinides form a wide variety of complex species in which hybridization must involve the normally unoccupied higher energy orbitals (6d, 7s, 7p) and this can be expected only with the more strongly coordinating ligands. Thus stable complexes, other than the hydrated cations in solution, are formed most commonly with ligands which contain highly electronegative donor atoms, such as oxygen. All of the actinides are radioactive and are therefore extremely toxic; because of this, work with all of these elements, except natural Th and U must be carried out in glove-boxes and, since the quantities available of the transcurium elements are very small, work with them is restricted to microscale studies. (BBB)

10191 DETERMINATION OF MOISTURE ON THORIUM DIOXIDE BY A COULOMETRIC ELECTROLYTIC MEASUREMENT WITH ELECTRONIC INTEGRATION. **Schaefer, E. A.; Hibbits, J. O. (General Electric Co., Cincinnati). Talanta, 15: 129-32(Jan. 1968).**

The coulometric electrolytic principle was utilized for the measurement of moisture sorbed on sintered thorium dioxide. Moisture was removed from the sample by heating, and was swept by dry argon gas through a hygrometer. The resulting hygrometer output was converted into frequency pulses and counted cumulatively. The instrument was calibrated by use of standard hydrated chemicals. The number of counts/μg of water obtained from standards compared favourably with the theoretical number of counts/μg calculated from performance specifications of the components employed. The error was <5% for 1 to 350 μg of water. The method is recommended for application to materials other than thorium dioxide, having very low moisture contents. (auth) (UK)

10192 DETERMINATION OF STRONTIUM IN ENVIRONMENTAL MEDIA. **Strong, Ann B.; Rehnberg, Georgia L.; Moss, Ursula R. (Southeastern Radiological Health Lab., Montgomery, Ala.). Talanta, 15: 73-7(Jan. 1968).**

A procedure is described for the determination of strontium in natural materials by flame photometry. An alkaline fusion of the ashed sample, followed by dissolution in dilute acid, gives a preliminary separation. Further separation of strontium is obtained by sorption on Dowex-50 resin from an EDTA solution at pH 5.1, followed by elution of the alkali metals with 0.5M hydrochloric acid, and of the strontium with 3M hydrochloric acid. The emission line at 460.7 mμ is used, and the intensity enhanced by the addition of s-butanol to the solution. (auth) (UK)

10193 THE GEOCHEMISTRY OF Sc: A COMPARISON TO THE RARE EARTHS AND Fe. **Norman, Jack C.; Haskin, Larry A. (Univ. of Wisconsin, Madison). Geochim. Cosmochim. Acta, 32: 93-108(Jan. 1968).**

Results of neutron activation analyses for Sc and Fe in 76 samples of igneous and sedimentary rock, including 9 composites, are reported. The highest Sc contents (average, 30 to 40 ppM) were found in basalts and gabbros, and the lowest in nepheline syenites and limestones (~1 ppM). No evidence for the close geochemical relationship that might be expected between Sc and the heaviest rare earths on the basis of ionic size, charge, electronegativity, etc. was found. The presently available evidence does not support predictions for a close geochemical relationship between Sc^{3+} and Fe^{2+}, Mg^{2+}, or any other major element or ion in igneous rocks. A possible coherence between Sc and Fe in sedimentary rocks was found. (auth) (UK)

10194 A METHOD FOR COLLECTING $^{14}CO_2$ FROM A HYDROGEN FLAME DETECTOR. **Robbins, J. D.; Bakke, J. E. (Dept. of Agriculture, Fargo, N. D.). J. Gas Chromatogr., 5: 525-6(Oct. 1967).**

A simple, inexpensive, and sensitive method that can be routinely used to rapidly monitor gas-liquid chromatography (GLC) effluents for the presence of ^{14}C-labeled metabolites is described. Gases from an enclosed hydrogen flame detector were passed through a 15-ml pipette coated with ethanolamine for the trapping of $^{14}CO_2$. A solution of ethylene glycol monomethyl ether and 2,5-diphenyloxazole in toluene was used for liquid scintillation counting of the soluble carbonate. Propazine (2-chloro-4,6-bis(isopropylamino)-s-triazine), uniformly ring labeled, was used to test the recovery of $^{14}CO_2$ from the system. Recoveries of radioactivity from the injection of 2.4 to 9.2 μg (216 cpm/μg) of Propazine-^{14}C varied from 42 to 66%. Sensitivity of this procedure was comparable to or exceeded the sensitivity of other methods. More than 20% of the radioactivity was registered as cpm in the liquid scintillation counter. The lowest amount of Propazine-^{14}C chromatographed (518 cpm) was easily detected. Also sensitivity was not decreased by splitting the effluent, which is necessary in other methods. (BBB)

10195 TRACE ANALYSIS OF HALOGENS BY NEUTRON ACTIVATION. **Allen, Ralph O. Jr. (Argonne National Lab., Ill.). Proc. Iowa Acad. Sci., 72: 139-44(1967).**

From Proceedings of the Iowa Academy of Science, Dubuque, Iowa. See CONF-650461.

A procedure was developed by which trace quantities of chlorine, bromine, iodine, tellurium, and uranium could be quantitatively determined simultaneously in a single meteorite sample. Meteoritic material was irradiated with thermal neutrons. Carrier ions were added, the material was fused with sodium peroxide and chlorine, bromine, and iodine were isolated. Distillation from a sulfuric acid solution removed the halogens from the bulk of material. After distillation, selective solvent extractions were used to separate and purify each of the halogens. The purified halides were precipitated as the silver halides, weighed, mounted, and counted by β, γ, and/or β-γ coincidence counting techniques. (auth)

10196 EXTRACTIVE SEPARATION OF MICROQUANTITIES OF THORIUM FROM THE LARGE QUANTITIES OF RARE EARTH ELEMENTS. **Sun, I-liang; T'ang, Jen-huan; He, Yu-lien; Chang, Tseng-p'u; Ch'eng, Chen-ch'i; He, Shou-ch'un. Yuan Tzu Neng, No. 12, 103ε-44(1965). (In Chinese).**

A study was made of conditions of the use of N-benzoyl-N-phenyl-hydroxylamine (I) and 1-phenyl-3-methyl-4-benzoyl-5-pyrazolone (II) as extractants for separating microquantities of

Th from the large quantities of rare earth elements, as well as small quantities of U and Zr. While using (I), Zr is separated first with 0.2M solution of (I) in $CHCl_3$, and then at pH 4 (acetate buffer solution) Th is extracted with a 0.2M solution of (I) in isoamyl alcohol. Small quantities of U are separated by ion exchange. In applying (II), use is made of a 0.05M solution of II in $CHCl_3$ or in xylene. In the first case, Th, Zr, and a small quantity of UO_2^{2+} are extracted. Then, UO_2^{2+} is removed by washing twice with 0.19N HCl, and Th is reextracted by means of 6N HCl (Zr remains in organic phase). In the second case, the separation of Th is performed by a 4- to 5-fold extraction with 0.00625M solution of (II) in xylene, washing with 0.19N HCl solution, and reextraction with 6N HCl. In all cases Th is determined by means of Arsenazo III. Using this method Th is determined in presence of UO_2^{2+}, Ce^{3+}, La, Y, Al, Mn, Cr, Fe^{3+}, PO_4^{3-}, and SO_4^{2-}. Time of determination is one hour. (JPRS)

10197 ON TREATING OF HAIR BEFORE NEUTRON ACTIVATION ANALYSIS. Dubinskaya, N.; Pelekis, L.; Tsirkunova, I. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 10-18(1967). (In Russian).

The behavior of Na, Cu, Zn, and Mn in the human hair during treatment with hot water including boiling water was studied. A short boiling of hair in distilled water as a method of treating the hair before irradiation was recommended. The advantages of the proposed method were considered to be the almost complete removing of Na, the speed of treating and the possibility of instrumental analysis of several microelements (Al, Au, Cu, Hg, Mn, Sb, Zn). (auth)

10198 SPECTROPHOTOMETRIC STUDY OF THE VIOLET COMPLEXES OF PYROCATECHOL–THORIUM IN AQUEOUS SOLUTION AT pH = 3.2 AND THE ACTION OF SULFATE IONS ON THESE COMPOUNDS. Prevost, Sylviane (Faculte des Sciences, Paris). J. Chim. Phys., 64: 1533-9(Oct. 1967). (In French).

In investigating a colorimetric determination of microamounts of sulfate ions where the sample contains zirconium salts, the spectrophotometric method was used. The complex employed was prepared from a 10^{-4} M pyrocatechol violet (VP) solution at pH = 3.2 in the relation Th : I VP. Complex formation was studied with a sulfanilate buffer (pH = 3.2), and the effect of sulfate ions on the complexes formed was investigated. When the VP concentration was 10^{-3}M/3 the complex Th : I VP exhibited a good sensitivity to sulfate ions, and it was possible to determine microamounts of sulfate ions if the sample solution is without a cation that would give a colored, soluble complex with the dye. (auth)

10199 DETERMINATION OF TRACE ELEMENTS BY CHEMICAL ANALYSIS AND NEUTRON ACTIVATION IN METEORITES OF THE COLLECTION OF THE VIENNESE MUSEUM OF NATURAL HISTORY. 2nd COMMUNICATION. Kiesl, W.; Seltner, H.; Kluger, F.; Hecht, F. (Univ., Vienna). Monatsh. Chem., 98: 972-92(June 1967).

Neutron activation and chemical separation techniques, used for analysis of six olivine-hypersthene chondrites, one pyroxene-plagioclase-achondrite, one medium and one coarse octahedrite, as well as an ataxite of high Ni content, are described. For activation, a flux of 10^{13} neutron cm^{-2} sec^{-1} was used. The time of irradiation varied from 60 to 120 hr. After a cooling period of 1 day, weighed amounts of the meteorite samples were mixed with the corresponding carrier solutions (5 to 8 mg amounts of the elements) and transferred to a quartz distillation apparatus for hydrogen halide distillation. The following elements to be determined were found in the distillate: Se, As, Sb, Sn, Hg, and Re, while the residue contained, among others, the elements Zn, Co, Sc, Cr, Au, and Ir. Methods are outlined for separating and determining Se, as ^{75}Se, As, as ^{76}As, Sb, as ^{124}Sb, and then the elements in the distillation residue. For the wet-chemical determination of the main constituents a rapid method of analysis was developed which was found to be very suitable. For the final determination of the elements, methods based on chelatometric fluorescence titration in uv light were employed. For the trace elements a separation method was developed which allowed the analysis of 12 elements in one operation. This separation technique is applicable after neutron activation to isotopes with half-lives exceeding 24 hr. (BBB)

10200 NEUTRON ACTIVATION ANALYSIS IN MEDICINE. Frischauf, H. (Univ., Vienna). Wien. Klin. Wochensch., 77: 916-19(Nov. 19, 1965). (In German).

The measurement by neutron activation analysis and biological significance of several trace elements, including I, Fe, Mn, Cu, Zn, Co, Se, Mo, and Cr, is reviewed. Uses of neutron activation analysis for detection of trace elements and heavy metal impurities in drugs and measurement of Na, K, Cl, and Ca in tissue samples are discussed. In vivo activation of Na and Cl in humans by use of 2 doses of 0.05 R of neutron irradiation was successfully carried out. The correlation of irradiation dose from neutrons with the in vivo activation of Na to form ^{24}Na could be valuable for improved evaluation of irradiation exposure received in the event of atomic reactor incidents. The two facts that are characteristic of the present status of neutron activation analysis are first of all that the utmost care is required to prepare samples that are as free as possible of contaminants, and second, that various trace elements were detected in blood and tissues to which no specific biological role can be assigned as yet. (BBB)

10201 URANIA SOL FORMING METHOD IN THE PRESENCE OF FORMIC ACID AND A PALLADIUM-ON-THORIA CATALYST. McBride, John P.; Pattison, William L. (to United States Atomic Energy Commission). U. S. Patent 3,361,676. Jan. 2, 1968.

A stable UO_2 sol was prepared from an acid-deficient uranyl formate slurry in the presence of formic acid and a dispersing acid by hydrogen reduction in the presence of a palladium-on-thoria catalyst. (auth)

10202 STEROID HORMONE ANALYSIS. VOLUME 1. Carstensen, Hans (ed.). New York, Marcel Dekker, Inc., 1967. 504p. $23.50.

Techniques for determining steroid hormones and their metabolites are described, and their possibilities and limitations discussed. Topics covered include: isotope derivative methods with ^{35}S-sulfonylating reagents, infrared spectroscopy, NMR methods, gas chromatography, testosterone, paper chromatography, and analysis and identification of steroid conjugates. (M.C.G.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 10290, 10310, 10348, 10350, 10917, 10964, 10965, 11003, 11011–11014, 11048, and 11217.

10203 (COO–977-1) FINAL REPORT [ON THE STRUCTURE OF MOLECULES AT HIGH TEMPERATURES]. Bonham, Russell A. (Indiana Univ., Bloomington. Dept. of Chemistry). Jan. 5, 1967. Contract AT(11-1)-977. 4p. Dep. CFSTI.

Work was carried out on the effect of temperature on the vibration of molecules in the gas phase. Theoretical techniques were developed to calculate electron scattering results for diatomic molecules for temperatures up to 2,000°C. Values of ΔH for the dissociation of dimers of formic acid molecules were obtained and the data indicate that the hydrogen bond is weakened by deuterium substitution. Precise bond lengths, bond angles, and mean amplitudes of vibration were obtained for both the monomers and dimers. (auth)

10204 (COO–1149-102) LOW-TEMPERATURE CHEMICAL THERMODYNAMICS PROJECT. Technical Progress Report No. 15, November 1966–November 1967. Westrum, Edgar F. Jr. (Michigan Univ., Ann Arbor. Dept. of Chemistry). Nov. 1, 1967. Contract AT(11-1)-1149. 33p. Dep. CFSTI.

Research progress is reported on facilities and instrumentation, studies on actinide compounds and materials of nuclear energy relevance, studies on lanthanide compounds, enthalpies of combustion of selected compounds composed of globular molecules, thermodynamic properties of condensed bicyclic globular molecules, and heat capacities of miscellaneous molecules. (M.C.G.)

10205 (LA–3744) SEMI-THEORETICAL MODEL FOR CALCULATING THE ACTIVITIES OF NIOBIUM AND CARBON IN NIOBIUM MONOCARBIDE AS A FUNCTION OF COMPOSITION. DePoorter, Gerald L. (Los Alamos Scientific Lab., N. Mex.). Dec. 1966. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Semi-theoretical equations were derived to represent the composition dependence of the niobium and carbon activities in niobium monocarbide. Empirical parameters are given for 1500 to 3000°K, typical results for the composition dependence of the activities are shown for 2500°K. Calculated results agree well with available measured quantities. (auth)

10206 (NYO–3211-6) MEASUREMENTS OF RATES OF ISOTOPIC EXCHANGE REACTIONS AT ELEVATED TEMPERATURES, AS STUDIED IN SHOCK TUBES. Bauer, S. H. (Cornell Univ., Ithaca, N. Y. Dept. of Chemistry). Dec. 1967. Contract AT(30-1)-3211. 13p. Dep. CFSTI.

All single-pulse shock tubes were operated under improved control. More sophisticated computer programs became available for computing general equilibrium conditions behind incident and reflected shocks. Improvements were made in obtaining analytical data of shock-heated and rapidly quenched samples. The technique of "cleaning up" mixtures of various isotopic species of hydrogen

without inducing scrambling was mastered. Experiments were run on mixtures of C_2H_2 with D_2, C_2H_2 with C_2D_2, and C_2H_4 with D_2. The mechanism that best accounts for results observed includes vibrational excitation of acetylene and subsequent formation of molecular dimers. Hydrogen exchange occurs through rearrangement during the dimer stage. For $C_2H_2 + O_2$ the product dideutero compound was found to be approximately half that of the monosubstituted product while for $C_2H_4 + D_2$ the amount of disubstituted product produced was very small, of the order of one-fifteenth that of the monosubstituted specie. Shock-tube data were obtained for homogeneous isotopic exchange between D_2 and H_2S, $^{32}O_2$ and $^{36}O_2$, and HD molecules. Studies were also made of vibrationally hot, translationally cold molecules. (M.C.G.)

10207 (UCRL-17915) MOLECULAR STRUCTURE OF STRONG ACIDS. Gargrave, Wayne E. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 25p. Dep. CFSTI.

Thesis.

The activities of perchloric acid and water were derived from available vapor pressure data. Various checks of the involved calculation were devised and used. Activities give information about the molecular structure and are indispensable in the interpretation of other data. Measurements of the rate of the reaction $H_2SO_4 + H_2O_2 = H_2SO_5 + H_2O$ confirmed the undissociated molecule H_2SO_4 as an intermediate. Thus rate determinations, in addition to Raman intensities and nuclear magnetic resonance, furnish a third method of exploring the molecular constitution of strong acids. Partial substitution of H by D did not change the rate. (auth)

10208 (UCRL-17948) MOLECULAR-BEAM ELECTRIC-RESONANCE SPECTRA OF THE LITHIUM HYDRIDES. Rothstein, Elaine (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 23, 1968. Contract W-7405-eng-48. 70p. Dep. CFSTI.

Thesis.

Radio-frequency spectra were observed in the first rotational state of ^{7}LiH, ^{7}LiD, ^{6}LiH, and ^{6}LiD by the molecular-beam electric-resonance method. Analysis of the spectra made possible the determination of accurate dipole moments and nuclear-hyperfine interaction constants. The experimental values are compared to the available quantum mechanical calculations. The polarizable ion model is also compared to the experiment. (auth)

10209 CONTRIBUTION TO THE INVESTIGATION OF KINETICS AND MECHANISM OF DISSOLVING URANIUM OXIDES IN SULPHURIC ACID SOLUTIONS. Neumann, Leo (Chemical Engineering Univ., Prague). Jad. Energ., 14: 21-3(1968). (In Czech).

The results of investigations of dissolution kinetics and mechanisms of uranium oxides in sulfuric acid solutions carried out during the last ten years are summarized. The solution to some problems in uranium ore leaching was the aim of these investigations. (auth)

10210 FORMATION, HYDROLYSIS, AND OLATION OF URANIUM(IV) CHELATES. Carey, G. H.; Martell, A. E. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1020. J. Amer. Chem. Soc., 90: 32-8(Jan. 3, 1968). (ORO-3621-2).

A procedure is outlined for the preparation of pure standard U(IV) chloride solution containing a known amount of excess acid, and potentiometric equilibrium data are reported for the formation of U(IV) chelates of ethylenediaminetetraacetic acid (EDTA), nitrilotriacetic acid (NTA), trans-1,2-cyclohexanediaminetetraacetic acid (CDTA), N-hydroxyethylethylenediaminetriacetic acid (HEDTA), N-hydroxyethyliminodiacetic acid (HIMDA), diethylenetriaminepentaacetic acid (DTPA), and triethylenetetraminehexaacetic acid (TTHA). The formation constants were calculated, and the tendencies of these metal chelates to form hydroxo derivatives and olated polynuclear species are outlined. The relative stabilities are correlated with the tendencies of the aqueous chelates to undergo hydrolysis and dimerization. Although the U(IV) chelates are more stable and show a greater tendency to hydrolyze than do the corresponding Th(IV) chelates, the U(IV) chelates show less tendency to form polynuclear species than do those of Th(IV). (auth)

10211 BORON COMPOUNDS. XIII. C-METHYL-B-PENTAETHYL-2-CARBAHEXABORANE(9). Grassberger, M. A.; Hoffmann, E. G.; Schomburg, G.; Koester, R. (Max-Planck-Institut fuer Kohlenforschung, Muelheim an der Ruhr, Ger.). J. Amer. Chem. Soc., 90: 56-8(Jan. 3, 1968).

Unique structural qualification can be obtained for the recently prepared C-methyl-B-pentaethyl derivative of 2-carbahexaborane(9) on the basis of its ^{1}H and ^{11}B NMR and infrared spectra. The chemical properties of this compound in some reactions were examined. No H/D exchange was observed when the compound was heated with tetraethyldideuteriodiborane. With sodium triethylborohydride a sodium salt of the carborane was obtained. Above 180°C decomposition with formation of closed-cage carboranes and benzene-insoluble solid occurred. (auth)

10212 MASS SPECTROMETRY IN STRUCTURAL AND STEREOCHEMICAL PROBLEMS. CXLIV. UNUSUAL FRAGMENTATIONS IN THE LOW-VOLTAGE SPECTRA OF ALIPHATIC KETONES. Carpenter, Wayne; Duffield, A. M.; Djerassi, Carl (Stanford Univ., Calif.). J. Amer. Chem. Soc., 90: 160-4 (Jan. 3, 1968).

An examination of the mass spectra of isotopically labeled aliphatic ketones at low voltage (10 eV) showed that deuterium scrambling occurred among carbon atoms of the aliphatic chains. The site specificity of the "protonated McLafferty rearrangement" ion was determined and an interesting reciprocal hydrogen-transfer process was shown to operate in the genesis of the peak at m/e 71 in the spectrum of 2-octanone. An ion corresponding to the McLafferty rearrangement plus 14 mass units was found to be an important fragmentation of aliphatic ketones at low voltage. (auth)

10213 PHOTOREDUCTION OF AROMATIC KETONES BY AMINES. STUDIES OF QUANTUM YIELDS AND MECHANISM. Cohen, Saul G.; Chao, Helen M. (Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc., 90: 165-73(Jan. 3, 1968).

Photoreduction of aromatic ketones by aliphatic amines in nonpolar media led to products, rates, and stoichiometry similar to photoreduction by alcohols and ethers. However, the initial light-induced abstraction of hydrogen appeared to show characteristics different from those in the oxygen compounds. Quantum yields for photoreduction at 334 mμ of benzophenone by 2-butylamine, N-methyl-2-butylamine, and N,N-dimethyl-2-butylamine were 1.13, 0.31, and 0.12, respectively. Rates of photoreduction by the primary amine fell very slightly on dilution with benzene, leading to $k_q/k_r = 0.03$ M, $k_r = 3 \times 10^6$ M^{-1} sec^{-1}. Rates of photoreduction by the tertiary amine rose with dilution with benzene, the quantum yield being 0.40 at 0.26 M amine. A light-absorbing transient was formed in the tertiary amine, less so on dilution with benzene, accounting at least in part for the increase in rate with dilution. No light-absorbing transient was observed with the primary amine. Efficiency of transfer of hydrogen from a tertiary amine to an excited ketone compared favorably with that from a primary amine. Photoreduction by the primary amine was insensitive to physical quenchers, $k_q/k_r \cong 40$ for naphthalene $k_q/k_r \cong 100$ for ferrocene. Photoreduction by optically active 2-butylamine and N,N-dimethyl-2-butylamine led to no racemization in recovered amine, indicating that reversible hydrogen abstraction from the asymmetric α-C did not occur. Photoreduction in cyclohexylamine-1-d showed a small kinetic deuterium isotope effect, $k_H/k_D \cong 1.6$. Photoreduction in primary amines containing $-ND_2$ proceeded slightly more rapidly than in the $-NH_2$ analogs. It is proposed that excited ketone, probably triplet, may abstract an electron or otherwise interact with the lone pair of nitrogen in a rapid process with which physical quenchers compete ineffectively. This is followed by electron return, equivalent to quenching, or by proton transfer from carbon, leading to the initial free radicals. The reaction is effectively inhibited by mercaptan and the later stages are normal free radical reactions. (auth)

10214 ELASTASE-CATALYZED HYDROLYSIS OF p-NITROPHENYL TRIMETHYLACETATE. Bender, Myron L.; Marshall, Thomas H. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 90: 201-7(Jan. 3, 1968).

The hydrolysis of excess p-nitrophenyl trimethylacetate by the enzyme elastase is a two-step process consisting of a fast initial liberation of p-nitrophenol followed by a slower linear turnover. The initial rate of the former reaction shows pure first-order dependence on substrate concentration without preequilibrium complex formation while the rate of the latter reaction shows a Michaelis–Menten behavior. The over-all reaction is interpreted in terms of an acyl-enzyme intermediate whose deacylation is rate determining in the over-all reaction. Further support for an acyl-enzyme intermediate includes: maximum turnover rates for the o- and p-nitrophenyl trimethylacetates are the same whereas their basic hydrolysis rates are 4.9-fold different, and tris(hydroxymethyl)aminomethane and methanol accelerate the enzymic hydrolysis rate, an effect consistent with an accelerating effect on the rate-determining deacylation. The pH dependence of the initial rate of the presteady-state (acylation) reaction is a sigmoid curve with an inflection point at pH 6.7. The steady-state (deacylation) reaction exhibits a bell-shaped pH-rate profile with apparent pK's of 6.7 and 10.5. The pK of 6.7, in each instance, is interpreted as indicative of the catalytic participation by a neutral imidazole group. The substantial deuterium oxide solvent isotope effects, found both in acylation and deacylation reactions, are interpreted as evidence for general base catalysis. (auth)

10215 ACTION OF VARIOUS URANIUM(VI) OXYCHLORIDES ON PYRIDINE. Camelot, Michel (Faculte des Sciences, Besancon, France). Compt. Rend., Ser. C, 265: 812-15(Oct. 9, 1967). (In French).

The following compounds were obtained: $UO_2Cl_2 \cdot 4C_5H_5N$, by the action of pyridine on UO_2Cl_2; $UO_2Cl_2 \cdot C_5H_5N \cdot H_2O$, by the action of pyridine on $UO_2Cl_2 \cdot H_2O$ or by the careful hydrolysis of $UO_2Cl_2 \cdot 4C_5H_5N$; and $U_2O_5Cl_2 \cdot 3C_5H_5N$, by the action of pyridine on $UO_2Cl_2 \cdot C_5H_5N \cdot H_2O$ or on $UO_3 \cdot HCl$. Some related reactions among other compounds were observed. (tr-auth)

10216 INFLUENCE OF THE DIFFUSION OF FERRIC IONS ON THE OXIDATION KINETICS OF URANIUM DIOXIDE (UO_2) AND THE OXIDE (U_3O_8) IN SULFURIC ACID MEDIUM. Tinturier, Bernard; Kikindai, Tivadar (Ecole Centrale des Arts et Manufactures, Paris). Compt. Rend., Ser. C, 265: 769-72 (Oct. 9, 1967). (In French).

It is possible to predict the kinetics of a slow solid–liquid reaction carried out in a diffusion medium taking into account the chemical conditions maintained at the interface by the diffusion. The oxidation of uranium dioxide (UO_2) and of the oxide (U_3O_8) by ferric ions in a sulfuric acid medium was carried out, and the equations obtained were verified. The influence of the diffusion was confirmed by the low values of the activation energy. (tr-auth)

10217 ISOTOPE EFFECTS IN AUTOXIDATIONS; SECONDARY β DEUTERIUM ISOTOPE EFFECT IN THE THERMAL DECOMPOSITION OF AZOBISISOBUTYRONITRILE-d_{12}. Rummel, Siegbert; Huebner, Heinrich; Krumbiegel, Peter (Institut fuer Stabile Isotope, Leipzig). Z. Chem., 7: 351-2(Sept. 1967). (In German).

First order kinetics were found for the thermal decomposition of azobisisobutyronitrile to nitrogen and 2-cyanoisopropyl radicals. In toluene between 65 and 80°C, k_H/k_D ranged from 1.21 to 1.24; in chlorobenzene at 65°C, k_H/k_D was 1.34. This value was compared with literature values for secondary effects, and the mechanism of transmission of the effect via hyperconjugative and inductive routes was reviewed. The present case was judged to be principally the result of a hyperconjugative mechanism; this was in agreement with the explanation provided by the rate decrease in azocyanoalkanes in which H atoms are replaced by methyl groups. Calculations indicate a steric effect as well. The solvent dependence is unexplained. (BBB)

10218 REACTIONS OF $^3HeH^+$ IONS WITH GASEOUS HYDROCARBONS. I. TOLUENE. Cacace, Fulvio; Caronna, Sergio (Univ., Rome). J. Amer. Chem. Soc., 89: 6848-54 (Dec. 20, 1967).

The gas-phase reaction of $^3HeH^+$ ions from the decay of molecular tritium with toluene was investigated under conditions ensuring that the labeled decay fragments were the only source of tritiated products, with no significant interference from radiolytic processes. The reaction responsible for the formation of tritiated toluene, the major product isolated with a yield of 50 to 60%, appears to be similar to the electrophilic aromatic substitutions occurring in solution, as indicated by experiments involving the competition for the $^3HeH^+$ ions between toluene and benzene, and benzene and α-trifluorotoluene, and by the analysis of the isomeric distribution of the tritiated toluenes formed. The mechanisms responsible for the formation of the two other products identified, i.e., labeled methane and benzene, are also discussed. (auth)

10219 CAGE REACTIONS IN THE THERMAL DECOMPOSITION OF ACETYL PEROXIDE. Taylor, James W.; Martin, J. C. (Univ. of Illinois, Urbana). J. Amer. Chem. Soc., 89: 6904-11(Dec. 20, 1967).

Isotopic tracer methods provide evidence for an unexpectedly large amount (ca. 38%) of cage recombination of acetoxy radicals in the thermal decomposition of acetyl peroxide in isooctane at 80°C. The reactions leading to ethane and methyl acetate were shown to be very cleanly intramolecular (>99 and >99.8%, respectively) using deuterium-labeling techniques. This result combined with the observation that methyl acetate is formed from acetyl-carbonyl-^{18}O peroxide with complete scrambling of label to confirm earlier conclusions that these are products of cage reactions. These results are compatible with a mechanism involving simple O–O bond cleavage to yield a pair of acetoxy radicals which can recombine or decarboxylate (followed by recombination of the product radicals) in reactions competitive in rate with diffusion from the cage. Ratios of rate constants for these processes were deduced from the product distribution. (auth)

10220 EFFECT OF PRECEDING MER UNITS ON STEREOSPECIFIC POLYMERIZATION FOUND IN OLIGOMERS OF ISOPROPYL ACRYLATE. Yoshino, Tsuneo; Komiyama, Jiro; Iwanaga, Hikaru (Toyo Rayon Co., Kanagawa, Japan). J. Amer. Chem. Soc., 89: 6925-31(Dec. 20, 1967).

A series of oligomers was prepared by adding heavy water to a solution of isopropyl acrylate-α, β-d_2, that was polymerizing by an anionic mechanism under conditions that give, without hydrolysis, a highly diisotactic polymer through trans opening of the double bond. NMR analysis of the products showed that the oligomers comprised a homologous series, all mer units of which had isotactic α-methine configurations. The first and second units of each oligomer, however, had β-methylene carbons of nearly random configuration and all units added later had isotactic β configurations corresponding to trans opening of the double bond like the high polymers produced in this system. Apparently regular isotactic placement of the terminal α-methine carbon of a growing anion does not require the prior occurrence of an isotactic placement and is independent of the mode of incorporation of the β carbon of the terminal unit into the growing chain. Mer units other than the last two of a growing anion are not required to direct the mode of approach of another monomer into a transition state. (auth)

10221 ISOTOPE EFFECTS ON THE BASICITY OF 2-NITROPHENOXIDE, 2,4-DINITROPHENOXIDE, HYDROXIDE, AND IMIDAZOLE IN PROTIUM OXIDE–DEUTERIUM OXIDE MIXTURES. Pentz, Lipot; Thornton, Edward R. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-3041. J. Amer. Chem. Soc., 89: 6931-8(Dec. 20, 1967).

The ion product of D_2O was found to be 1.38×10^{-15} M^2 at 25°C using precisely calibrated glass electrode measurements. The ion products of D_2O–H_2O mixtures were also precisely measured. The value of the constant K_a for the equilibrium $DO^- + (\frac{1}{2})H_2O \rightleftharpoons HO^- + (\frac{1}{2})D_2O$ was calculated by nonlinear least squares to be 2.120 ± 0.190 at 25°C from data on the dissociation of 2-nitrophenol; data on other acids from the literature, used in similar calculations, gave similar values for K_a. Precise data on imidazole in D_2O–H_2O mixtures was also determined. Corrections for measurements of pL (L = H and/or D) in D_2O–H_2O mixtures (using a glass electrode and pH meter) are given. (auth)

10222 SECONDARY ISOTOPE EFFECTS IN THE SOLVOLYSIS OF NORBORNYL BROMIDES. Schaefer, John P.; Dagani, Michael J.; Weinberg, David S. (Univ. of Arizona, Tucson). J. Amer. Chem. Soc., 89: 6938-44(Dec. 20, 1967).

Optically active deuterated norbornyl bromides were prepared and their solvolyses were studied. The following secondary isotope effects (k_H/k_D) per D were observed or calculated: 3,3-d_2-exo-norbornyl bromide, 1.04 (polarimetric), 1.02 (titrimetric); 7,7-d_2-exo-norbornyl bromide, ~1.0; 3,3-d_2-endo-norbornyl bromide, 1.16; 2-d-endo-norbornyl bromide, 1.28. An analysis of these results suggests that, in the solvolysis of endo-norbornyl bromide, the degree of bond breaking that has occurred at the transition state is abnormally large. It is suggested that this is a result of unfavorable steric interactions between the departing halide and the C_6 methylene group. The strikingly low isotope effects observed in the exo series are consistent with the proposal that the transition state for the ionization of exo-norbornyl derivatives is delocalized and nonclassical. However, the absence of a detectable isotope effect from the 7 position suggests that the geometry of the norbornyl skeleton has not yet undergone a major change in this stage. (auth)

10223 THE DECARBOXYLATION OF p-METHOXY-β-METHYLCINNAMIC ACID. SOLVENT ISOTOPE EFFECTS AND ACID CATALYSIS. Noyce, Donald S.; Gortler, Leon M.; Kirby, Fred B.; Schiavelli, Melvyn D. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 89: 6944-7(Dec. 20, 1967).

In dilute aqueous sulfuric acid, p-methoxy-β-methylcinnamic acid undergoes decarboxylation by a reaction that shows strong acid catalysis. In the region of 10 to 25% sulfuric acid, this reaction was characterized by a rate-determining proton transfer as shown by the fact that the solvent kinetic isotope effect, k_{H_2O}/k_{D_2O}, was 3. In more concentrated sulfuric acid (above 40%), the rate-limiting process changed as shown by the abrupt change in the solvent isotope effect, k_{H_2O}/k_{D_2O} decreasing to 1.7. (auth)

10224 MECHANISM AND CATALYSIS OF THE HYDROLYSIS OF A FORMAMIDINIUM COMPOUND. Robinson, Dwight R.; Jencks, William P. (Massachusetts General Hospital, Boston. Brandeis Univ., Waltham, Mass.). J. Amer. Chem. Soc., 89: 7088-98(Dec. 20, 1967).

The hydrolysis of the amidine, 1,3-diphenyl-2-imidazolinium chloride (DPIC), to N-(2-anilinoethyl)-formanilide (AEF) in aqueous solutions at 25°C, ionic strength 1.0 M, follows the rate law $v = k_2[DPIC][B] + k_3[DPIC][B]\alpha_{OH^-}$, where B is a general base or hydroxide ion. Catalysis was observed by all of the 26 different bases examined, many of which have no dissociable proton, and the k_3 terms account for most of the observed reaction above pH 9. Nucleophilic attack of the bases on DPIC was ruled out. The pres-

ence of the term in the rate law that is second order in base is evidence for a two-step mechanism. The mechanism proposed involves addition of solvent to DPIC to form a tetrahedral addition intermediate followed by rate-determining general base catalyzed breakdown of the intermediate to form AEF. Mechanistically, the observed general base catalysis in the k_3 reaction is shown to involve the general acid catalyzed breakdown of an anionic tetrahedral intermediate. Structure–reactivity correlations and comparison with the mechanism of imido ester aminolysis suggest that the mechanism of the k_2 reaction involves general base catalyzed breakdown of the conjugate acid of the neutral tetrahedral intermediate. The increased reactivity of bicarbonate ion and the greater reactivity of phosphate dianion than methyl phosphate dianion in the k_3 reaction suggest that bifunctional acid-base catalysis by these compounds is slightly more efficient than monofunctional catalysis. (auth)

10225 ON THE MECHANISM OF H–D EXCHANGE IN ACETYLENE AT INTERMEDIATE TEMPERATURES: A RESPONSE. Bauer, S. H.; Jeffers, Peter; Zevos, Nicholas (Cornell Univ., Ithaca, N. Y.). J. Phys. Chem., 71: 4412-16 (Dec. 1967).

Data on the rates of substitution of D for H during shock heating of deuterium–acetylene mixtures are briefly summarized. For the strictly homogeneous reaction (ambient gas 90 to 98% Ar) over the approximate temperature range 1100 to 1500°K, the empirical power rate expression, the observed activation energy, ratios of the products generated, and study of the rates as they were affected by admixing a variety of selected reagents all favor a mechanism which involves a molecular complex intermediate, rather than a free radical chain. Several experiments expressly designed to provide tests for these alternate mechanisms are described; those which have been completed support the molecular complex route. (auth)

10226 DEUTERIUM OXIDE SOLVENT ISOTOPE EFFECTS ON N–H...O, O–H...N, AND N–H...N INTRAMOLECULAR HYDROGEN BONDS. Haslam, John L.; Eyring, Edward M. (Univ. of Utah, Salt Lake City). J. Phys. Chem., 71: 4470-5(Dec. 1967).

Equilibrium and kinetic solvent deuterium oxide isotope effects were measured for tropaeolin O, 2,4-dihydroxy-4′-nitroazobenzene, N,N-dimethylanthranilic acid, N-methyl-N-ethylanthranilic acid, N,N-diethylanthranilic acid, and 3,7-diaza-3,7-dimethyl-1,5-diphenyl-9-hydroxybicyclo[3.3.1] nonane. The solvent kinetic isotope effects for the reaction $HA + OH^- \rightarrow A^- + H_2O$ lie between 3.6 and ~1.2 for these compounds. The rate constants measured in water by the temperature jump-relaxation technique for the various intramolecular hydrogen bond types overlap to some extent but roughly confirm an earlier generalization based on spectroscopic data that intramolecular hydrogen bonds have strengths that decrease in the following order from left to right: O–H ... N > O–H ... O ≅ N–H ... N > N–H ... O. The kinetic data emphasize that structural variations in a molecule near its intramolecular hydrogen bond have a greater impact on the reactivity of the bond than the fact, say, that it is an O–H . . . N rather than an O–H . . . O bond. (auth)

10227 SOLVENT TRANSPORT AND THE ELECTROMOTIVE FORCE OF ANION EXCHANGE MEMBRANE CELLS CONTAINING HEAVY AND NORMAL WATER SOLUTIONS OF ALKALI HALIDES. Greyson, Jerome (Atomics International, Canoga Park, Calif.). J. Phys. Chem., 71: 4549-51(Dec. 1967).

An investigation of anion-exchange membrane cells containing heavy and normal water solutions of bromide and iodide ions was continued. Results indicated a variation in emf resulting from solvent transport in a particular anion-exchange membrane as a function of halide ion type. The emf was found to be almost independent of the activity ratios of the two solutions. The effects of the differences in viscosity of H_2O and D_2O on the results are discussed. (J.G.B.)

10228 INTERACTION OF URANYL NITRATE WITH DIMEDON AND 1,3-INDANDIONE. Kukushkin, Yu. N.; Markhaeva, D. M. Radiokhimiya, 9: 517-19(1967). (In Russian).

The compounds of uranyl with dimedon and 1,3-indandione were prepared. It is proposed that in these compounds β-diketones do not have closed rings and the monodentates of the ligands appear. (tr-auth)

10229 THORIUM CITRATE. Skorik, N. A.; Kumok, V. N.; Serebrennikov, V. V. Radiokhimiya, 9: 515-17(1967). (In Russian).

The neutral thorium citrate $Th_3(C_6H_5O_7)_4 \cdot 7.5H_2O$ was synthesized, and its solubility in 0.1M solutions of (H, Na)ClO_4 was measured. The product of the salt solubility and the formation constants of the complex $ThC_6H_5O_7^+$ were determined. (tr-auth)

10230 INVESTIGATION OF THE KINETICS OF THE DISPROPORTIONATION OF NEPTUNIUM(V) IN OXALATE SOLUTIONS. Krot, N. N.; Mefod'eva, M. P.; Smirnova, T. V.; Gel'man, A. D. Radiokhimiya, 9: 449-60(1967). (In Russian).

The kinetics of the disproportionation of Np(V) in oxalate solution at pH 1 to 3.5 were investigated spectrophotometrically. It was found that generally the process proceeds reversibly. However because of the reduction of one of the reaction products Np(VI) with oxalate ions the disproportionation in the final result comes down to the transition of Np(V) to the tetravalent state. Some characteristics of the reduction of Np(VI) in oxalate media were studied. An explanation is given of the results obtained on the basis of the assumption of stepwise complex formation of NpO_2^{2+} and $C_2O_4^{2-}$. The effects of the concentration of hydrogen ions and ammonium oxalate on the disproportionation rate of Np(V) was studied. The kinetic equations for the disproportionation are given for the neutral and weakly acid media and for acid media. The results are explained on the basis of the formation and dissociation of Np(V) oxalate complexes. From the temperature dependence of the constants of the disproportionation rate, the activation energy was found to be E = 16.2 kcal/mole in 0.074 M $(NH_4)_2C_2O_4$ at pH = 1.5 and μ = 0.23. A great similarity was found with respect to the disproportionation of Np(V) and Pu(V) in oxalate media. It was concluded that the disproportionation reactions in both cases proceed by a similar mechanism. (tr-auth)

10231 PREPARATION AND PROPERTIES OF HYDRATED URANIUM(III) SULPHATE. Barnard, R.; Bullock, J. I.; Larkworthy, L. F. (Univ. of Surrey, London). Chem. Commun., No. 24, 1270-2(1967).

The isolation of $U_2(SO_4)_3 \cdot 8H_2O$ is reported. This salt was crystallised by addition of ethanol under nitrogen to the solution obtained by electrolytic reduction of uranyl sulphate in dilute H_2SO_4 at a mercury cathode. The solid was olive green and very soluble in water, with which it reacted rapidly to give a less soluble, pale green U(IV) sulphate. The dry compound was moderately stable in dry air. The results of magnetic studies are given. Sparingly soluble double sulphates of U(III), analogous to those of the lighter lanthanides, were also prepared. (UK)

10232 CRYSTALLOGRAPHIC STUDY OF THE COMPOUNDS $Ba_3UFe_2O_9$ AND $Sr_3UFe_2O_9$. Ropars, C.; Berthon, J.; Bernier, J. C.; Poix, P. (Faculte des Sciences, Orsay, France). Ann. Chim. (Paris), 1: 377-82(1966). (In French).

A study of these mixed oxides was conducted to determine conditions for their preparation and their structures. A crystallographic study of the 2 compounds $BaUFe_2O_9$ and $Sr_3UFe_2O_9$ provided their respective lattice constants, 8250 and 8066 Å. Intensity measurements of x-ray diffraction lines suggested a distribution of the U and Fe atoms on the crystallographic positions 4a and 4b (Wyckoff's notations). The space group is Fm 3m for $Ba_3UFe_2O_9$ and Fm 3m or perhaps Pa 3 for $Sr_3UFe_2O_9$. Density measurements showed that the unit cell includes 8/3 of formula weights $Me_3UFe_2O_9$ in the 2 samples studied. Therefore, the formula of these substances can best be expressed: $Me_8[Fe_4(Fe_{1.5}U_{1.5})]O_{24-x}$, where $x \leq 0.3$. This expression takes into account possible deviations in oxygen stoichiometry. (BBB)

10233 ROTATIONAL ISOTOPE EFFECT IN THE ($A^3\pi_i - X^3\Sigma^-$) SYSTEM OF NH AND ND. Shimauchi, Midori (Kyoiku Univ., Tokyo). Sci. Light (Tokyo), 15: 161-5(Oct. 1966).

A method was devised for obtaining the emission spectrum of pure NH or ND, by use of a hollow cathode discharge through a flowing mixture of He, N_2, and H_2 (or D_2 of 99.9% purity). The hollow cathode discharge suppressed the N_2 bands, and the amount of N_2 for producing NH or ND spectrum was so small that no trace of the N_2 bands except the (0,0) band of the first negative system could be seen. Because of this simple method of making ND, the H_2O or H_2 adsorbed on the internal surface of the apparatus could be easily replaced by D_2O or D_2, and not even a trace of the strongest line or the head of the NH spectrum could be observed in the ND spectrum. The rotational constants, B_0', D_0', H_0', B_1', D_1' and H_1' of the $A^3\pi_i$ state were determined. The satellite branches, $^PQ_{12}$, $^RQ_{21}$, $^PQ_{23}$, $^RQ_{32}$, and $^QP_{32}$, were recognized by the observation of several low N lines belonging to each of these branches. Within experimental error these lines are situated at the position predicted by Schlapp's formulae with $\lambda = 0.928$ and $\lambda = -0.0285$ cm^{-1}, assuming the usual isotope relation between the γ values of NH and ND. The rotational constants, B, D, and H of the $X^3\Sigma^-$ state calculated in the method of least squares are listed. They coincide with those found by Kopp et al. The rotational constants of the $A^3\pi_i$ state and the band origins of the (0,0) and (1,1) bands were obtained from the mean energies of the Λ doublets. (BBB)

10234 PHOTO-OXIDATION OF ISOPROPANOL BY URANYL PERCHLORATE IN AQUEOUS ACID MEDIUM. Venkatarao, K.;

Santappa, M. (Univ., Madras). Indian J. Chem., 5: 304-6 (July 1967).

Photochemical oxidation of isopropanol by uranyl perchlorate in aqueous perchloric acid (1.0 M) was studied with visible light of wavelength 436 mμ at 35°C. The reaction was followed by measuring the rate of uranous ion production that was found to be proportional to light intensity and to light absorption fraction by the active species. Hydrogen ion concentration, ionic strength, initially added product (acetone), and temperature were found to have no effect on the rate. Initially added U^{4+} decreased the rate slightly, acting as an internal filter. Formation of an intermediate complex between uranyl ion and isopropanol is suggested. Excitation of the complex by light, in a primary photochemical act, and decomposition of the excited complex by electron transfer mechanism in the dark are suggested to explain the mechanism of oxidation. (auth)

10235 POLAROGRAPHY OF URANIUM IN ACETATE BUFFER MEDIUM. Athavale, V. T.; Dhaneshwar, R. G.; Padmanabha Iyer, C. S. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 5: 313-15(July 1967).

Uranyl ion reduction was studied in acetate buffer medium. Two waves were obtained for all pH. The second wave vanished at higher acetate concentrations. The wave characteristics of the first wave were studied for different acetate concentrations as well as under different pH conditions. Three successive uranyl acetate complexes were found to be present. The stability constants of these complexes were studied by Hume's method. The applicability of Hume's method to the uranyl acetate system is discussed. (auth)

10236 STABILITY OF BIVALENT METAL COMPLEXES WITH α-CARBOXY-β-METHYLTROPOLONE. Gupta, B. P.; Dutt, Yag; Singh, R. P. (Univ. of Delhi). Indian J. Chem., 5: 322-3(July 1967).

Stability constants of uranyl, nickel, cobalt, zinc, and cadmium complexes with α-carboxy-β-methyltropolone were determined in 0.2N sodium perchlorate medium by potentiometric methods. The values of log K_1 of the complexes formed by the metal ions as well as by other members of group II were also determined by spectrophotometric method. The order of stability for the metal complexes investigated was found to be UO_2 > Cu > Ni > Zn > Co > Cd > Mn > Mg > Ca > Sr > Ba. (auth)

10237 INTERPRETATION OF INFRARED SPECTRA OF CHEMISORBED HYDROGEN AND DEUTERIUM. Smith, W. Hayden; Eckstrom, H. C.; Bar, F. (Univ. of Kentucky, Lexington). J. Phys. Chem., 72: 369-72(Jan. 15, 1968).

A group theoretical model was applied to the discussion of spectra for H_2 and D_2 on polycrystalline rhodium substrates. Observation of a group of bands for the Rh–H_2 system at 2114 to 2193 cm^{-1} and a displaced group at 1506 to 1584 cm^{-1} for the Rh–D_2 system provided a convincing assignment of these bands as due to chemisorbed hydrogen. In an effort to assign the 4372-cm^{-1} band observed in the evacuated Rh–H_2 system, the symmetry properties of H_2 chemisorbed on a crystalline substrate are discussed and it is shown that the molecular stretching mode is thereby formally allowed in the infrared spectra. It was concluded that the 4372-cm^{-1} band is due to hydrogen, molecularly chemisorbed in a linear fashion on rhodium film upon certain undetermined, but similar, crystallographic faces. In the 3000- to 2000-cm^{-1} regions the large number of bands observed are attributed to multiple crystallographic sites available on the polycrystalline films. (D.N.M.)

10238 INFRARED SPECTRA OF KAOLIN MINERAL–DIMETHYL SULFOXIDE COMPLEXES. Olejnik, S.; Aylmore, L. A. G.; Posner, A. M.; Quirk, J. P. (Univ. of Western Australia, Nedlands). J. Phys. Chem., 72: 241-9(Jan. 15, 1968).

Dimethyl sulfoxide (DMSO) intercalates into the kaolin minerals and increases the basal spacing d(001) from 7.14 A to approximately 11.16 A. The rate of intercalation was measured and found to increase in the order: halloysite > kaolinite > dickite. An explanation of the observed intercalation rates based on the structure of the kaolin minerals and the numbers of interlayer hydrogen bonds is given. The infrared spectra of the kaolin minerals–DMSO complexes were examined. DMSO hydrogen bonds via its oxygen atom to the clay hydroxyl surface. The hydrogen bonding involves predominantly the 3690-cm^{-1} hydroxyls of the clay and results in the appearance of sharp peaks at approximately 3658, 3535, and 3499 cm^{-1}. Deuteration of the complex confirms that these peaks are due to perturbed hydroxyls. A model consistent with the infrared and X-ray data is suggested to account for the bonding of the DMSO to the internal surfaces of the clay. (auth)

10239 IONIC REACTIONS OF UNSATURATED COMPOUNDS. I. POLYMERIZATION OF ACETYLENE. Futrell, Jean H.; Tiernan, Thomas O. (Aerospace Research Labs., Wright–Patterson AFB, Ohio). J. Phys. Chem., 72: 158-64(Jan. 15, 1968).

Ion–molecule reactions of acetylene were investigated in conventional, high pressure, and tandem mass spectrometers. Evidence was obtained from ionization efficiency curves and from charge-exchange experiments for the existence of an excited molecule ion, $C_2H_2^{+*}$, with an appearance potential of about 15.9 eV, which reacts differently from the ground vibronic state ion, $C_2H_2^+$. Reactions of the individual primary ions and selected secondary, tertiary, and subsequent ions were investigated, and C_2D_2 was examined in some experiments to clarify mechanistic details and to evaluate isotope effects. A highly branched chain reaction for the ionic polymerization of acetylene was deduced from these results. (auth)

10240 REACTIONS OF TRITIUM ATOMS PRODUCED BY ELECTRON IMPACT ON T_2 WITH SOLID PROPENE AND PROPANE. Shores, R. D.; Moser, H. C. (Kansas State Univ., Manhattan). Contract AT(11-1)-584. J. Phys. Chem., 72: 1-4(Jan. 15, 1968). (COO-584-26).

A beam of electrons of 30 to 50 eV energy was used to dissociate T_2 gas in a region adjacent to a surface of solid propene or propane at 77°K. The principal tritium-containing products from propene reactions were HT, propene, propane, 2,3-dimethylbutane, 2-methylpentane, n-hexane, and 4-methyl-1-pentene. The principal tritium-containing hydrocarbon products from propane reactions were methane, ethane, ethene, propane, and propene. The products are interpreted as having resulted from various reactions of hot and thermal T atoms. The T atoms are proposed to result from the decomposition of the $^3\Sigma_u$ state of molecular T_2 yielding T atoms with energies of 2.2 to 5.2 eV. (auth)

10241 THE CATALYTIC SPECIES IN THE LABILIZATION OF RHODIUM(III) COMPLEXES BY REDUCING AGENTS OR HYDRIDE-PRODUCING COMPOUNDS. Rund, John V. (Univ. of Arizona, Tucson). Inorg. Chem., 7: 24-7(Jan. 1968).

Several kinetic aspects of the catalyzed reaction $RhCl_6^{3-}$ + 4py → $[Rh(py)_4Cl_2]^+$ + $4Cl^-$ (py = pyridine) were examined in an effort to distinguish between the two proposed mechanisms for the reaction, one involving a rhodium(I) intermediate and the other a hydrido-rhodium(III) complex. Catalysts containing rhodium(I) compounds are found to be more active than those containing reducing (and/or hydride-producing) reagents such as sodium borohydride, ethanol, or molecular hydrogen. Hydrido complexes of rhodium(III) show little of no catalytic activity. It is found that the reactive rhodium(III) compounds do not turn into hydride complexes under the conditions of the pyridination reaction. The primary kinetic isotope effect required by the hydride-catalyst mechanism does not occur, but instead a small solvent isotope effect consistent with a rhodium(I) catalyst is found. The addition of o-phenanthroline inhibits the pyridination reaction, and this is interpreted in terms of its action as a scavenger for catalytic rhodium(I). (auth)

10242 A TEST FOR OXIDATION OF ACTINIDES IN CONCENTRATED CsF SOLUTIONS. Holcomb, H. P. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem., 29: 2885-8(Dec. 1967).

A chemical test was devised to differentiate between tracer concentrations of the actinide(III) state and higher oxidation states in 12 to 15M CsF. Attempts to oxidize Cm(III) and Cf(III) with sodium perxenate in this matrix were unsuccessful, although Am(III) was readily oxidized. (auth) (UK)

10243 POLAROGRAPHY OF URANYL-IMINODIACETATE COMPLEX. Lai, Tsai-teh; Chen, Tsung-yu (Cheng Kung Univ., Tainan, Taiwan). J. Inorg. Nucl. Chem., 29: 2975-81 (Dec. 1967).

The reduction of uranyl ion in iminodiacetate solution at the dropping mercury electrode was studied in detail. The reversibility held at pH 1.80 to 11.00 and ligand concentration 0.14M to 0.80M. The pH values at the two breaking points in $E_{\frac{1}{2}}$ vs pH plots were in excellent agreement with pK_1 and pK_2 of iminodiacetic acid. At pH < pK_1, the complex species $UO_2(HA)_2$ was identified. At pK_1 < pH < pK_2, the coexistence of $UO_2(HA)_2$ and $UO_2A_2^{2-}$ was confirmed. At pH > pK_2, the complex species $UO_2(OH)A_2^{3-}$ was formed. The uranium(V)-iminodiacetate complexes were proved to be stable toward disproportionation, and to undergo polymerization at high pH value. The pK value of $UO_2(HA)_2$ complex was found to be 3.92 ± 0.01. (auth) (UK)

10244 SOLVENT EFFECT ON THE KINETICS OF ISOTOPIC EXCHANGE AT AROMATIC CARBON ATOM. II. IODINE EXCHANGE IN ACETONE–METHANOL MIXTURES. Marcopoulos, Ch. A. (Democritus Nuclear Research Center, Athens). Z. Phys. Chem. (Leipzig), 236: 64-73(1967).

Isotopic exchange between KI labeled with ^{131}I and 1-iodo-2,4-dinitronaphthalene or 1-iodo-2,4-dinitrobenzene was studied in various acetone-methanol mixtures. Runs were carried out at 45°C and for a wide range of iodide concentrations and methanol percentage in the solvent mixtures. To follow the increasing activity of the organic compound a liquid scintillation technique was adopted. Rates and the order of the reaction in respect to iodides were determined. A possible explanation is given for the change of the order with the methanol percentage in the solvent mixtures. (auth)

10245 THORIUM SULFITE COMPOUNDS WITH NEUTRAL ORGANIC LIGANDS. Golovnya, V. A.; Molodkin, A. K.; Tverdokhlebov, V. N. Zh. Neorg. Khim., 12: 2729-39(Oct, 1967). (In Russian).

The following previously unknown sulfite compounds of Th, containing neutral organic molecules as ligands, were synthesized: $Th_2O(SO_3)_3(CH_3)_2CO \cdot 7H_2O$, $Th_2(SO_3)_4((CH_3)_2CO)_3 \cdot 3H_2O$, $Th_2(SO_3)_2Cl_2(OH)_2(CH_3)_2CO \cdot 3H_2O$, $Th_2(SO_3)_2(OH)_4CH_3CONH_2 \cdot 5H_2O$, $Th_2(SO_3)_3(OH)_2(CH_3CONH_2)_2 \cdot 4H_2O$, $Na_4Th_2(SO_3)_3(OH)_8(CO(NH_2)_2)_2 \cdot 20H_2O$, $Na_6Th_2(SO_3)_7(CO(NH_2)_2)_2 \cdot 15H_2O$, and $Na_6Th_2(SO_3)_6CO(NH_2)_2 \cdot 12H_2O$. The compounds obtained were investigated by thermographic, thermogravimetric, infrared spectrometric, and NMR spectrometric methods. Their stability and indices of refraction were determined. On the basis of the studies made the presence of stable Th–O bonds in the carbamide and acetamide were established. A sharp change in the stability of the bonds of the amide hydrogen in the carbamide molecule coordinated in the sulfite Th compound was observed. A mechanism for the thermal decomposition of the compound is proposed. (tr-auth)

10246 HYDROGEN EXCHANGE BETWEEN DEUTERIUM AND CHARGE-TRANSFER COMPLEXES. Inokuchi, H.; Mori, Y.; Wakayama, N. (Tokyo Univ.). J. Catal., 8: 288-9(July 1967).

Some charge-transfer complexes of the type alkali metal–polycyclic aromatic compounds catalyze the para-ortho H conversion and the H–D exchange reaction, indicating that the H and D molecules are chemisorbed on the surface of solid organic charge-transfer complexes. Similar phenomena were found with the complexes of phthalocyanine with Na. Further, when D_2 gas was introduced onto the charge-transfer complexes, it was found that H–D exchange takes place between D and the complexes. The decay of the concentration of D in the gas phase and also the increase of H–D and of H removed from the violanthrene B–Cs complex (H-ϕ) as a function of time, are shown. For these exchange reactions, the following 2 schemes are proposed: $D_2 + H - \phi \rightleftharpoons HD + D - \phi$ and $HD + H - \phi \rightleftharpoons H_2 + D - \phi$, where $D - \phi$ is the deuterized complex. The 1st reaction is predominant at an initial state of this exchange reaction. To confirm the H – D exchange reaction, the component of the charge-transfer complexes, the aromatic hydrocarbon, was analyzed by mass spectroscopy. This exchange reaction occurs reversibly. This reversible behavior suggests that the complexes between certain aromatic compounds and alkali metal atoms may be similar to the model for hydrogenase, an enzyme. (BBB)

10247 OXYGEN ION CONDUCTING SOLID ELECTROLYTES AND POSSIBILITIES OF THEIR APPLICATION: COMPOSITION AND SYSTEMATICS OF SOLID ELECTROLYTES WITH OXYGEN ION CONDUCTANCE. Moebius, Hans-Heinrich (Univ., Greifswald, Ger.). Z. Chem., 4: 81-94(Mar. 1964). (In German).

On the basis of physical, chemical, and crystal chemical properties oxides are selected, which are anticipated to be useful in the construction of oxygen ion-conducting solid electrolytes. The literature was examined in connection with structures in mixed systems of fundamental oxides, and general properties of mixed phases with oxygen ion vacancies were established. Mixed oxides with the fluorite structure were examined in particular, and a correlation of the oxygen ion radius and effective cation radius was established. Mixed phases with ThO_2 are considered in detail, where the foreign ion is a lanthanide; several ternary mixtures containing ThO_2 are tabulated. A definition of the range in which solid electrolytes that conduct through oxygen ions may be said to exist is proposed. (BBB)

10248 X-RAY SINGLE-CRYSTAL AND POWDER DIFFRACTION RESULTS FOR CAESIUM HEPTAFLUOROPROTACTINATE (V). Brown, D.; Easey, J. F.; Holah, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 12, 1979-80(1967).

Single-crystal studies showed that Cs_3PaF_7 possesses monoclinic symmetry, with $a_0 = 14.937$, $b_0 = 7.270$, $c_0 = 8.266$ Å, and $\beta = 125.32°$, space-group $C2/c - C_{2h}^6$. (auth) (UK)

10249 VAPOR PRESSURES OF SOME DEUTERATED ALCOHOLS AND AMINES. Kiss, I.; Jakli, Gy.; Jancso, G.; Illy, H. (Central Research Inst. for Physics, Budapest). J. Chem. Phys., 47: 4851-2(Dec. 1, 1967).

The effects of deuterium on the vapor pressures of ethanol, 1-propanol, 1-butanol, 2-propanol, 2-butanol, 3-pentanol, methanol, 2-methyl-2-propanol, methylamine, ethylamine, and propylamine were studied. (M.C.G.)

10250 MOLECULAR MOTION AND ^{19}F RELAXATION IN THE LIQUID HEXAFLUORIDES OF MOLYBDENUM, TUNGSTEN, AND URANIUM. Rigny, Paul; Virlet, Joseph (CEN, Saclay, France). J. Chem. Phys., 47: 4645-52(Dec. 1, 1967).

In order to study molecular motion in liquid molybdenum, tungsten, and uranium hexafluorides, a ^{19}F relaxation study in these liquids was undertaken. Measurements of the relaxation times as a function of resonance frequency showed that the dominant relaxation mechanism is the modulation of the spin-rotation interaction by the molecular motions. It is shown that the strengths of the spin-rotation interactions, which were not measured directly, can be deduced very simply from the chemical-shift tensors if some approximations are made. The molecular motion is discussed with the help of a generalized Langevin equation in which it is not required that the particle under consideration be much heavier than the molecules interacting with it. It was thus found that the hexafluoride molecules in the liquid phase can rotate through an angle of about 1 rad at 70°C before their angular velocity changes and that this intermediate degree of rotation is consistent both with the low values of the entropies of fusion, which indicate that the rotations do not occur freely, and with the appearance of rotation-vibration structures in their infrared absorption spectra. The self-diffusion coefficients were also measured as a function of temperature. The relationship between the diffusion coefficients and the longitudinal relaxation times is not in agreement with Hubbard's theory, and this is attributed to the failure of both the Stokes' equation and the rotational diffusion model. (auth)

10251 ELEMENT 104: KURCHATOVIUM. White, Sarah. New Sci., 37: 85-7(Jan. 11, 1968).

Methods of synthesis and chemical identification of element 104 that appeared in the Soviet journal Priroda (1967, No. 11, p. 35) are described. (D.H.M.)

10252 TERNARY FLUORIDES OF TYPE $Me^{II}Me^{IV}F_6$ WITH LaF_3 STRUCTURE. Keller, C.; Salzer, M. (Technische Hochschule, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 29: 2925-34 (Dec. 1967). (In German).

The following ternary fluorides of Me(II)Me(IV)F_6 composition were obtained by reaction in the solid state and/or by precipitation reactions: CaMe(IV)F_6 (Me(IV) = Th, U, Np, Pu), SrMe(IV)F_6 (Me(IV) = Ce, Th, U, Np, Pu) BaMe(IV)F_6 (Me(IV) = Th, U, Np), PbMe(IV)F_6 (Me(IV) = Ce, Th, U, Np), CdThF$_6$, and EuThF$_6$. These compounds possess the hexagonal LaF_3-type structure and statistical distribution of the metal ions. There is a solubility of 25 to 27 mole % MeF_2 in Me(II)Me(IV)F_6 at 950°C. The solubility of SrF_2 in CeF_2 is 15 mole %, and that of $BaThF_6$ in BaF_2 is 37 mole %. It could be deduced from density measurements that the solid solutions in the system MeF_2–Me(II)Me(IV)F_6 have anionic vacancies. $BaHfF_6$ possesses the cubic $BaZrF_6$-type structure. A preliminary structural diagram for the ternary fluorides of Me(II)Me(IV)F_6-composition was established. (auth) (UK)

10253 CHELATE FORMATION OF TRIVALENT TRANSPLUTONIUM ELEMENTS WITH N-2-HYDROXYETHYL(ETHYLENEDIAMINE)-N,N'N'-TRIACETIC ACID. Eberle, S. H.; Bayat, I. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 7: 214-16(Aug. 1967). (In German).

The reactions of tri-valent Am, Cm, and Cf with N-2-hydroxyethyl (ethylenediamine)-N,N'N'-triacetic acid were studied by the cation exchange method. The cerium compound of the acid was used as method control. The distribution coefficient of the trivalent ions decreases sharply with increasing ion strength. The results showed that all four ions give tan $\alpha = 1$ form a neutral chelate of the formula MeHEDTA. The tan α value gradually increases which indicates a further reaction of the actinide(III)-1:1 chelate up to the 1:2 chelate. The constants of the ion exchange equilibrium were calculated. The stability constants of different amino polycarbonic acids are graphed. (J.S.R.)

10254 VAPOR PRESSURES OF ISOTOPIC METHANES: EVIDENCE FOR HINDERED ROTATION. Bigeleisen, J.; Cragg, C. B.; Jeevanadam, M. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 47: 4335-6(Dec. 1, 1967).

The liquid-vapor separation factors of CH_3T and $^{14}CH_4$ from $^{12}CH_4$ were determined over the temperature range from 90 to 120°K by the column-distillation technique. $^{14}CH_4$ was less volatile than $^{12}CH_4$ over the measured temperature range; CH_3T showed the crossover at 103.9°K. The reduced partition function ratios

derived from the elementary separation factors are: $Inf_c/f_g(^{14}CH_4/^{12}CH_4) = 231/T^2 - 1.42/T$ and $Inf_c/f_g(CH_3T/^{12}CH_4) = 503/T^2 - 4.83/T$. The reduced partition functions of all the deuteromethanes and $^{13}CH_4$ in the liquid and solid phases were derived from known vapor-pressure data. Comparison of the T^{-2} dependence of species of equal molecular weight but different moments of inertia, i.e., CH_3D and $^{13}CH_4$, and $^{14}CH_4$, CH_3T, and CH_2D_2, with model calculations led to the conclusion that the rotation in methane is hindered both in the liquid and the solid. (auth)

10255 MENDELEVIUM: DIVALENCY AND OTHER CHEMICAL PROPERTIES. Hulet, E. K.; Lougheed, R. W.; Brady, J. D.; Stone, R. E.; Coops, M. S. (Univ. of California, Livermore). Science, 158: 486-8(Oct. 27, 1967).

Mendelevium (element 101) is the first actinide element found to give a divalent ion stable in solution. Reduction from the 3+ oxidation state was accomplished with Zn dust, Zn–Hg amalgam, Cr^{2+}, Eu^{2+}, and V^{2+}; additionally, measurements of the equilibrium with V^{2+} provided an estimate of +0.2 volt for the couple, $Md^{2+} = Md^{3+} + e^-$. The chemical behavior of Md^{3+} is similar to that of the other trivalent actinides and lanthanides. Oxidation from the trivalent to higher valence states with sodium bismuthate was not detected. (auth)

10256 URANYL OXALATE SULFITE COMPLEXES. Zakharova, F. A.; Orlova, M. M. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim., 12: 2621-5(Oct. 1967). (In Russian).

The mixed uranyl oxalate sulfite complexes were synthesized and precipitated in the solid form. In the coordination sphere the oxalate and sulfite groups, $UO_2C_2O_4SO_3^{2-}$, were contained and in the external sphere Na^+, K^+, NH_4^+, and $CN_3H_4^+$. The instability constant of the complex ion $UO_2C_2O_4SO_3^{2-}$ was determined as 2.93×10^{-5} by the spectrophotometric method at $\mu = 1$. By the method of solution of uranyl oxalate in ammonium sulfite solutions the possibility of extensive addition of sulfite groups to $(NH_4)_2UO_2C_2O_4SO_3$ was found. The complex ion $UO_2C_2O_4(SO_3)_2^{4-}$ was identified and its stability constant was determined as 1.9×10^{-4} at $\mu = 2.5$. At $\mu = 1$ the instability constants of the corresponding oxalate, sulfite, and mixed oxalate sulfite complexes were compared. (tr-auth)

10257 ATTRIBUTION OF THE INFRARED SPECTRA OF THE CHLOROHYDRATES OF SOME α-AMINO ACIDS. Dupuy, Bernard; Garrigou-Lagrange, Chantal (Faculte des Sciences, Bordeaux. Institut de Magneto-Chimie, Brivazac-Pessac, France). J. Chim. Phys., 64: 1509-15(Oct. 1967). (In French).

An assignment of the infrared spectra of hydrogenated and deuterated glycine, DL α-alanine, and DL β-phenylalanine hydrochlorides is proposed. Modification of the vibrational couplings observed in the spectra of amino acids by addition of an H^+ or D^+ ion is often observed. (auth)

10258 A DEUTERIUM ISOTOPE EFFECT IN A NON-AQUEOUS ACID–BASE SYSTEM. Welch, David K.; Abell, Paul I. (Univ. of Rhode Island, Kingston). J. Org. Chem., 33: 457-60 (Jan. 1968).

A study was made to determine whether an isotope effect exists between HBr and DBr in their reactions with the π-electron system of several aromatic hydrocarbons. Benzene, toluene, and mesitylene were studied; an isotope effect occurred only in benzene and its magnitude was small, $K_H/K_D = 1.02$. (M.C.G.)

10259 MEASUREMENT AND CORRELATION OF SOME PHYSICAL PROPERTIES OF METHANE AND PER-DEUTERO-METHANE. Grigor, Anthony Frederick. University Park, Pa., Pennsylvania State Univ., 1966. 150p.

Thesis.

The physical properties of CH_4 and CD_4 were measured from their melting points (ca. 90°K) to their critical temperature (ca. 190°K) and the data were treated in terms of the quantum modification of the theorem of corresponding states. If the intermolecular potential functions of two species are conformal; that is, if the energy of interaction between the molecules of each species can be expressed as a universal function containing the two parameters which characterize the intermolecular function, the classical theorem of corresponding states can be applied to derive equations that relate the physical properties on isotopic substitution in terms of the intermolecular parameter, ϵ and σ (where ϵ is the depth of the potential curve and σ is its spatial extension). The quantum modification of the classical theorem of corresponding states also considers the effect of a change in mass of the molecular species. The physical properties measured were the densities, vapor pressures, isothermal compressibilities for CH_4 and CD_4, and the critical constants for CD_4. The changes in molecular volumes (obtainable from the densities) and in the vapor pressures were compared with the predictions of the theorem of corresponding states. Vapor pressures were measured in a conventional method with a mercury manometer at low pressures and a dead weight gauge at high pressures. The densities were measured with a density balance that was operated by balancing the changes in gravitational force due to the buoyancy of a sphere immersed in the fluid by varying the current through a coil mounted on one end of a balance beam and located in the field of a permanent magnet. The critical temperature (189.2°K) of CD_4 was ascertained by plotting the reciprocal of the isothermal compressibility (K_T) versus temperature and extrapolating $1/K_T$ to zero. By extrapolating a plot of the sum of the densities of the gas and liquid versus temperature to the critical temperature, the critical density (0.2045g/cc) was determined. The critical pressure (46.0 atm) of CD_4 could then be obtained from the P, V, T. surface. The experimental changes in molar volume agreed well with calculations based on the quantum modification of the theorem of corresponding states and yielded values of δ and γ ($\delta = [\epsilon_D - \epsilon_H]/\epsilon_H$ and $\gamma = [\sigma_D - \sigma_H]/\sigma_H$) of −0.011 and −0.0040, respectively. The values of the parameters were then used in the vapor pressure correlation. Although the correlation of the molar volumes to theory was good, the correlation of the vapor pressure was only fair because of the uncertainty in the fundamental vibrational frequencies of CH_4 and CD_4 gas and liquid which were necessary in the determination of the vibrational quantum effect. (Disser. Abstr.)

10260 CHLORINE AND DEUTERON RELAXATION TIME MEASUREMENTS IN LIQUID HCl AND DCl. Boehme, Hollis Clyde. College Station, Tex., Texas A and M Univ., 1967. 59p.

Thesis.

Measurements of chlorine T_2 in liquid HCl and DCl were made over the temperature range from −40°C to 60°C. Estimates of the reorientational correlation time made possible by the chlorine measurements were used to evaluate the proton intramolecular dipole contribution, which was subtracted from the total intramolecular contribution to obtain the proton spin–rotational contribution. The magnitude of the spin–rotational contribution thus obtained compares with that estimated by Krynicki and Powles. Deuteron T_1 times in liquid DCl were measured over the temperature range from −75°C to 25°C and found to differ considerably both in magnitude and temperature dependence from deuteron T_2 times. Estimates of the quadrupole contribution to the deuteron ($1/T_1$) and, thus, a value of 2.0×10^{17} volts/cm^2 for the electric field gradient at the deuteron site in DCl were made by use of the reorientational correlation time from chlorine measurements. The difference between experimental deuteron ($1/T_1$) and the deuteron quadrupole contribution to ($1/T_1$) was considered to be due to a deuteron–chlorine scaler interaction. The scalar contribution to the deuteron ($1/T_1$) and the experimental deuteron ($1/T_2$) were used to estimate the scalar coupling constant and deuteron exchange time in DCl. (Diss. Abstr.)

10261 ELECTROLYTIC REDUCTION OF URANYL SOLUTIONS. Parkinson, Norman (to United Kingdom Atomic Energy Authority). U. S. Patent 3,361,651. Jan. 12, 1966. Priority date Jan. 22, 1965, Great Britain.

A method was developed for the hydrolytic reduction solutions either having uranyl ion components where the valency of the component is to be reduced or having uranyl ion and plutonium ion components where the valency of either or both of these components is to be reduced. The method utilizes an electrolytic cell or series of cells having a tantalum cathode. (Offic. Gaz.)

10262 ELECTROLYTIC REDUCTION FOR SOLUTIONS CONTAINING NUCLEAR FUEL MATERIAL. Parkinson, Norman; Mowat, John Alistair Stevenson; Finlayson, Moira Baillie (to United Kingdom Atomic Energy Authority). British Patent 1,096,592. Dec. 29, 1967. Filed Jan. 22, 1965.

A process for the electrolytic reduction of solutions containing nuclear fuel materials consists of subjecting the solutions to electrolytic reduction using a Ta cathode. The solutions contain a mixture of U and Pu, and the electrolytic reduction serves to reduce the valency state of U if the solution contains only U or of at least one of the constitutents for a solution containing a mixture of U and Pu. The apparatus for effecting the reduction consists of at least two electrolytic cells each having a Ta cathode and connected in series for a flow of solution and in parallel for passage of current. The Ta cathode is in the form of an entanglement of wire disposed in an annular outer cathode compartment. (B.L.M.)

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Refer also to abstracts 10517, 11195, 11500, and 11946.

10263 (CEA-R-3228) CONTRIBUTION A L'ETUDE DE L'INFLUENCE DU SPECTRE ET DU FLUX INTEGRE SUR LES DOM-

MAGES CREES PAR LES NEUTRONS DANS LES SOLIDES. (Study of the Effect of the Energy Spectrum and of the Total Flux on the Damage Produced by Neutrons in Solids). Dulieu, Pierre Claude (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1967. 62p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

The general relation between the physical effects produced by neutrons in solids, and the total flux and neutron energy spectrum was studied. Some examples are given. A silicon damage detector whose function is to use the damage produced in a PIN junction for measuring the neutron flux (intermediate and fast) received by the detector was also studied. The energy given to the atoms by a primary in the silicon was determined experimentally. The results and conclusions drawn from this determination made it possible to consider the calculation of the detectors response characteristics. The detectors response function was measured, and it is noted that good agreement was obtained between the calculation and experimental results. (auth)

10264 (ORO-3602-1) REACTIONS OF CHARGED AND NEUTRAL RECOIL PARTICLES FOLLOWING NUCLEAR TRANSFORMATIONS. Progress Report No. 1, December 1966-August 1967. Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg. Dept. of Chemistry). Sept. 1967. Contract AT(40-1)-3602. 23p. Dep. CFSTI.

A study of the relative importance of kinetic energy and charge in determining the chemical fate of recoil particles, produced by nuclear transformations was made. A method was worked out and the necessary equipment was constructed, which will allow the study of the reactions of charged and neutral recoil species separately from each other. Parallel to these developments an attempt was made to determine the chemical state of recoil atoms when they come to rest in a solid matrix. (auth)

10265 (ORO-3632-1) RADIOLYTICALLY-INDUCED HETERGENEOUS REACTIONS WITH PERFLUOROCOMPOUNDS. Progress Report. Reed, T. M. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Nov. 1967. Contract AT(40-1)-3632. 24p. Dep. CFSTI.

The effects of radiation on products from the system CF_4-carbon and the system SF_6-carbon were studied. Samples were exposed to neutron flux for periods of 1 hr to 56 days. No radioactivity was observed in any of the irradiated CF_4-carbon samples. Diagrams show the products formed. Irradiation of the SF_6-carbon system produced radioactivity that increased in proportion to the exposure time. Products from the irradiation of 10 perfluoroalkanes at 25°C by 50 to 150 MRAD of γ rays were analyzed by chromatography. (M.C.G.)

10266 (TID-24223) INVESTIGATION OF ANOMALOUS RADIATION-INDUCED ELECTRON PULSES IN ORGANIC LIQUIDS. Final Report. Taimuty, S. I. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1967. Contract AT(04-3)-115. 23p. Dep. CFSTI.

Anomalous radioinduced electron pulses produced by ^{60}Co gamma radiation and first observed in some purified liquid paraffins were studied. Several cells incorporating guard rings and parallel-plate or coaxial geometry were used. Liquid paraffins studied were n-hexane, n-octane, n-hexadecane, cyclohexane, and n-octacosane. Pulses were observed in only one sample of n-octacosane and in none of the other materials. The phenomenon could not be reliably reproduced in the n-octacosane samples, and attempts to establish unequivocally the nature of the phenomenon were unsuccessful. (auth)

10267 (UCRL-Trans-10151) NMR AND ESR SPECTRA OF LITHIUM PLATELETS IN LiF. Taupin, C. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Compt. Rend., Ser. A and B, 263: 1617-20(1966). 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The small platelets formed by the aggregation of lithium atoms when a lithium fluoride crystal is irradiated with thermal neutrons give very characteristic NMR and ESR spectra, whose interpretation is discussed with the aid of a simple model. (auth)

10268 COMMERCIAL ASPECTS OF INSTANTANEOUS RADIATION CURING OF REINFORCED PLASTICS. Brenner, Walter (New York Univ., N. Y.); Oliver, William F. Isotop. Radiat. Technol., 5: 29-34(Fall 1967).

Electron-beam irradiation was used to cure glass-fiber-reinforced polyester laminates, prepregs, and molding compounds. The size and shape of articles that can be cured, commercially available machinery to provide sources of radiation, and processing costs are discussed. Physical properties of electron-beam and conventionally cured commercial laminates and prepregs are compared. With the advent of glass-fiber-reinforced polyester prepregs, radiation curing becomes a commercially feasible technique. (auth)

10269 CHLORINATION OF TOLUENE USING AN INTERNAL IONIZING-RADIATION SOURCE. Collins, Carol H. (Western New York Nuclear Research Center, Buffalo). Isotop. Radiat. Technol., 5: 34-44(Fall 1967).

Toluene can be chlorinated either by side-chain substitution or ring addition. Radiation-initiated and photoinitiated chlorination reactions yield the same products under the same reaction conditions. Ring addition predominates at temperatures below 20°C, while side-chain substitution occurs almost exclusively at temperatures above 80°C, producing benzotrichloride. Thus the choice of initiation source to be used for the side-chain chlorination of toluene would be determined by the most efficient way to optimize the chosen reaction conditions and by the comparative economics that would be obtained. No valid comparisons of the type of source can be made for the reaction of chlorine and toluene, as sufficient information is not available in the literature. However, comparisons of energy utilization for the chlorination of benzene indicate that gamma radiation is 8.5 times as effective as the most efficient ultraviolet source. Ionizing radiation would compare even more favorably with less efficient light sources. That this is true for the chlorination of toluene would have to be proved, however, since yields (G values) for the chlorination of both benzene and toluene depend on the reaction conditions as well as on the radiation source intensity. In determination of the preferable type of source, consideration of linear-energy-transfer (LET) effects indicate that a radiation source of low LET would produce fewer unfavorable side effects (such as radiolysis of benzene or toluene) while maximizing the yield of chlorination products. Although either a beta or a gamma source could meet the requirement of low LET, a properly constituted low-energy internal beta source would offer the potential of more efficient energy utilization coupled with a favorable minimization of radiation shielding requirements. (auth)

10270 OBSERVATION OF RADICAL RECOMBINATION AND MOLECULAR MOTIONS BY ESR AND NMR METHODS. Ero, Janosne; Gruner, Gyorgy; Tompa, Kalman; Toth, Ferenc. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 345-55(1967). (In Hungarian).

The recombination of free radicals, produced by irradiation with ^{60}Co γ rays at 77°K of 1,4-dicyclohexylcyclohexane (1-4-DCMCM), 1,4-dicyclohexylbenzene (1-4-DCMB), and p-cyclohexylbiphenyl (p-CMDF), was observed by ESR techniques. Parallel observation of molecular motions was performed on nonirradiated samples in the temperature range from 77°K to the melting point by NMR spectrometery. In 1-4-DCMCM the NMR lines indicated torsional motion of the molecule and at higher temperatures rotation about the longitudinal axis. In 1-4-DCMB a phase transition, while in p-CMDF a torsional bending, could be inferred from the NMR spectrum. The recombination processes of radical products observed by ESR measurement can be partly explained by the molecular motions. In the two latter compounds ESR results suggest that an intramolecular recombination takes place. (auth)

10271 THE RADIATION CHEMISTRY OF BIOCHEMICAL DISULFIDES. I. THE LOW-DOSE X-RADIOLYSIS OF CYSTINE. Owen, Terence C.; Rodriguez, Mariano; Johnson, Barrett G.; Roach, John A. G. (Univ. of South Florida, Tampa). J. Amer. Chem. Soc., 90: 196-200(Jan. 3, 1968).

All ninhydrin-positive products resulting from exposure of dilute solutions of cystine in sulfuric acid to moderate doses (1,000 to 80,000 RADS) of x rays were separated, identified, and determined quantitatively. Cysteic acid was the major product under all conditions. Yields varied with cystine concentration, dose rate, photon energy, and slightly with acidity, at low cystine concentrations. A mechanism for cysteic acid production is presented and a kinetic interpretation is given. These accommodate the concentration and dose-rate effects and are consistent with the photon energy effect and the amounts of hydrogen peroxide formed along with the cysteic acid. (auth)

10272 EFFECT OF IONIZING RADIATIONS ON NICKEL OXIDE. MODIFICATION OF THE NUMBER OF Ni^{3+} IONS. Gisquet, Eric; Destriau, Michel (Faculte des Sciences, Bordeaux). Compt. Rend., Ser. C, 265: 1027-9(Nov. 6, 1967). (In French).

Measurements of the variation in the number of Ni^{3+} ions in nickel oxide irradiated by gamma or x rays showed an increase in the number with the dose received. (tr-auth)

10273 EFFECT OF DENSITY ON THE FRAGMENTATION OF EXCITED IONS IN THE RADIOLYSIS OF BUTANES. Miyazaki,

Tetsuo (Tokyo Inst. of Tech.). J. Phys. Chem., 71: 4282-9 (Dec. 1967).

The effects of density on the radiolysis of isobutane and n-butane were studied by the ammonia method. The effects of ammonia on the radiolysis of isobutane at a density of 0.15 g cc^{-1} were found to be quite different from those at a density of 0.0032 g cc^{-1} (~1.9 atm). The yields of reaction intermediates in the formation of propane from isobutane were measured in the intermediate density region. The $C_3H_7^+$ ion, which was formed by the fragmentation of excited butane ion, was found to decrease with increasing density, and the collisional deactivation of the excited butane ion was confirmed. At low density the $C_3H_7^+$ ion produced propane via the hydride ion transfer reaction with isobutane, while at high density the neutralization of $C_3H_7^+$ ion became notable and competed with the hydride ion transfer reaction of the $C_3H_7^+$ ion. On the other hand, the C_3H_7 radical increased with increasing density and was formed by the neutralization reaction of the $C_4H_{10}^+$ ion which was formed by the deactivation of the excited butane ion. The effects of density on reaction intermediates in the formation of propane in the radiolysis of n-butane were also studied and a density effect similar to that on isobutane was found. Though the difference between the C–O bond dissociation energy of the $n\text{-}C_4H_{10}^+$ ion and that of the $i\text{-}C_4H_{10}^+$ ion amounted to 0.91 eV, the $C_3H_7^+$ ion from both butane ions showed the same density effect, that is the same rate of fragmentation. This result cannot be explained by the simple quasi-equilibrium theory, suggesting that a more rapid fragmentation process may be occurring to an appreciable extent. (auth)

10274 FRAGMENTATION OF EXCITED IONS IN THE RADIOLYSIS OF NEOPENTANE AND ISOOCTANE IN THE LIQUID PHASE. Tanno, Kuniyasu; Miyazaki, Tetsuo; Shinsaka, Kyoji; Shida, Shoji (Tokyo Inst. of Tech.). J. Phys. Chem., 71: 4290-3(Dec. 1967).

The fragmentation of an excited ion in the radiolysis of neopentane and isooctane in the liquid phase was studied by using ion scavengers such as sulfur hexafluoride and methylamine. The yields of $t\text{-}C_4H_9^+$ ion were measured with the result that $G(t\text{-}C_4H_9^+) = 1.0$ in the radiolysis of neopentane and $G(t\text{-}C_4H_9^+) = 0.36$ in the radiolysis of isooctane. The ionic mechanisms of the radiolysis of neopentane and isooctane are discussed. The ionic C–C bond rupture in the radiolysis of several saturated hydrocarbons in the liquid phase was classified into three reaction steps, that is, the fragmentation of the excited ion, the fragmentation by neutralization, and the deactivation of the excited molecule formed by the neutralization. (auth)

10275 RADIOLYSIS OF CARBON DIOXIDE IN THE ADSORBED STATE. Sutherland, J. W.; Sethi, D.; Goodrich, R. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 71: 4422-9(Dec. 1967). (BNL-11415).

The ^{60}Co γ radiolysis of CO_2 adsorbed on silica gel and on Linde Molecular Sieves 5A and 13X was investigated. Little decomposition occurred on the sieves. With silica gel the major product was CO, along with much smaller amounts of O_2 and H_2. The CO was only released from the surface by degassing at temperatures greater than 100°. To account for the high CO yields observed, energy transfer must occur from the sorbent to the sorbate. This apparent energy transfer can result from an indirect effect of energy absorption in surface silanol groups or can be equally well explained by energy-transfer mechanisms involving electrons, positive holes, or excitons. (auth)

10276 PULSE RADIOLYSIS OF POLYSTYRENE. Ho, S. K. (Aerospace Corp., El Segundo, Calif.); Siegel, Seymour; Schwarz, Harold A. Contracts AT(30-2)-Gen-16; AF 04(695)-669. J. Phys. Chem., 71: 4527-33(Dec. 1967). (BNL-11249).

Absorption spectra following the pulse radiolysis of polystyrene containing various solutes are reported. An absorption in samples containing triphenylamine was due to the positive ion of the solute. The lifetime of the ion was of the order of milliseconds and its disappearance was attributed to recombination with negative ions in the spur. Triplet states of anthracene, diphenyl, naphthalene, perylene, and p-terphenyl were identified. The lifetimes of the triplets were never greater than 20 msec at room temperature. Much longer lifetimes for naphthalene, diphenyl, and p-terphenyl triplets have been observed when they are produced by photolysis. The short lifetime in radiolysis was attributed to paramagnetic quenching in the spur. (auth)

10277 RADIATION CHEMISTRY OF AQUEOUS TETRANITROMETHANE SOLUTIONS IN THE PRESENCE OF AIR. Bielski, B. H. J.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 71: 4544-9(Dec. 1967). (BNL-11548).

Aerated tetranitromethane (TNM) solutions, pH 5 to 6, were reduced to nitroform by γ rays with an initial yield G = 3.4, independent of concentration and radiation intensity. The product nitroform competed with TNM for the reducing radicals; the oxidizing radicals reacted exclusively with the other product, nitrite ion. Addition of H_2O_2 converted the oxidizing radical to a reducing radical and increased the nitroform yield to 6.1; organic additives behaved similarly. TNM did not react with nitrite and peroxide, but was quantitatively reduced to nitroform by pernitrous acid; this reaction was used for determination of nitrite and of peroxide in the presence of TNM, and under γ-rays caused an increase in G(nitroform) with decreasing pH. All the work in near-neutral solutions was consistent with the radical yields $G_{OH} = 2.7$, $G_{e^-} + G_H = 3.4$. These are significantly higher than yield values deduced from certain other systems. (auth)

10278 RADIATION DECOMPOSITION OF SOLID CHLORATES. Burchill, C. E.; Patrick, P. F.; McCallum, K. J. (Univ. of Saskatchewan, Saskatoon). J. Phys. Chem., 71: 4560-1(Dec. 1967).

Irradiation of crystalline sodium, potassium, and barium chlorates by ^{60}Co γ rays followed by solution in water was found to lead to the formation of oxygen, chlorine dioxide, and perchlorate, chlorite, hypochlorite, and chloride ions. The general features of the product yields of the three chlorates were very similar, suggesting that the same general decomposition mechanism is operative. (J.G.B.)

10279 FORMATION OF ACETYLENE AND OTHER TWO-CARBON COMPOUNDS IN METHANE WITH ELECTRON PULSES. Cahill, R. W.; Seeler, A. K.; Glass, R. A. (Lockheed Research Lab., Palo Alto, Calif.). J. Phys. Chem., 71: 4564-6(Dec. 1967).

In the radiolysis of methane a high-current, pulsed electron generator was used to produce 20-nsec pulses capable of delivering dose rates of about 10^{14} RAD/sec and, with 1 to 20 pulses, total doses from 2×10^6 to 4×10^7 RAD. Acetylene and ethylene yields were enhanced considerably; those of ethane were substantially lower with the use of electron pulses. (J.G.B.)

10280 ACETYLENE PRODUCTION BY THE RADIOLYSIS OF METHANE. Rudolph, P. S.; Melton, Charles E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Phys. Chem., 71: 4572-3(Dec. 1967). (ORNL-P-3318).

The irradiation of methane with 100-eV electrons resulted in the production of acetylene with $G_{C_2H_2} = 0.7$. (J.G.B.)

10281 LIGHT-INDUCED AND RADIATION-INDUCED REACTIONS IN METHANOL. I. γ RADIOLYSIS OF SOLUTIONS CONTAINING NITROUS OXIDE. Sherman, Warren V. (Soreq Nuclear Research Centre, Yavne, Israel). J. Phys. Chem., 71: 4245-55 (Dec. 1967).

The gaseous products of the ^{60}Co γ radiolysis of methanol solutions containing nitrous oxide alone and in the presence of a number of solutes were studied. The results with organic solutes were consistent with simple competition between nitrous oxide and the solute for solvated electrons, and an estimate was made of the relative reactivities of these solutes. The effects of sulfuric acid on product yields were also studied. While the latter depressed the nitrogen yield efficiently, the results cannot be interpreted in terms of a simple competition between nitrous oxide and the hydrogen ion for the precursor of nitrogen. A chain reaction was observed in the radiolysis of solutions made alkaline with potassium hydroxide, with considerably enhanced yields of all three gaseous products (hydrogen, nitrogen, and methane). The chain length was found to be dose rate dependent. Inhibition of the chain was brought about by the addition of small concentrations of nitrobenzene, benzophenone, or carbon tetrachloride, while the presence of benzene even in high concentration had little effect. Catalysis of the chain reaction was observed in the presence of acetone. The mechanism of the chain reaction is discussed, and it was concluded that there is evidence for both the solvated electron and the methoxyl radical anion acting as chain carriers. (auth)

10282 CYCLOHEXANE DOSIMETER FOR ALPHA EMITTERS. Ezersko, K.; Pelka, Ya.; Taube, M. (Univ., Warsaw). Nukleonika, 12: 1037-9(Nov. 1967). (In Russian).

Cyclohexane was used for dosimetry of α particles from (^{239}Pu) plutonium. Tabulated data on the radiochemical yield of hydrogen from the cyclohexane (in hydrogen-free systems) showed a mean value of 5.4 molecules/100 eV. The absorbed dose, dose rate, and the plutonium decay calculated according to the cyclohexane data are also tabulated. (R.V.J.)

10283 A REVIEW OF DEVELOPMENTS IN DIMENSIONAL STABILIZATION OF WOOD USING RADIATION TECHNIQUES. Siau, J. F.; Meyer, J. A.; Skaar, C. (State Univ. Coll. of

Forestry, Syracuse, N. Y.). Forest Products J., 15: 162-6 (Apr. 1967).

Use of radiation for polymerization of monomers impregnated in wood, with resulting improvement in structural properties of the wood, is reviewed (35 references). Effects of radiation on cellulose and wood are also reviewed. The crystalline-amorphous nature of cellulose apparently is not changed by irradiation, as seen by ir absorption spectra and x-ray spectroscopy. No visible changes in the cellulose structure are noted at doses below 10^6 rad. Above this value the fibrillate nature is progressively lost. All the investigations of the effect of ionizing radiation on wood showed that the principal result at high doses is degradation. At doses above 10^6 RAD, the observed degradation is accompanied by an increase in hygroscopicity. The observed decrease in hygroscopicity at low doses of γ radiation may indicate cross-linking of the hemicelluloses or cellulose. Of the components of wood, lignin has the greatest resistance to irradiation, followed by cellulose, and then by the hemicelluloses. Studies on the dimensional stabilization of wood by impregnation with styrene followed by irradiation reveal that high-energy electron irradiation is much less efficient than γ irradiation for the initiation of polymerization at dose rates of 400,000 RAD/hr. Electron irradiation was found to produce the highest antishrink efficiency for a given polymer retention. Other monomers tested were methylmethacrylate, vinyl acetate, ethyl acrylate, and ethylene glycol dimethylacrylate. Treatment resulted in considerable increases in weight, hardness, and mechanical strength. (BBB)

10284 DETERMINATION OF G(-C) VALUES FOR P.G.A. AND OTHER GRAPHITES IN THE WINDSCALE AGR. Ashton, B. W.; Standring, J.; Jaquiss, M. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). J. Nucl. Energy, 21: 871-82(Dec. 1967).

The G-value for radiolytic oxidation of grade A graphite was determined in the Windscale AGR in various coolant atmospheres by direct measurement of weight loss and total radiation dose. Results obtained were 1.2 ± 0.08 atoms/100 eV in 0.35 vol % CO/CO_2, 0.95 ± 0.06 in 0.4 vol % CO/CO_2, and 0.37 ± 0.02 in 0.5 vol % CO/CO_2 + 400 vpm CH_4 + 475 vpm H_2O. Similar values were also obtained on graphites with both higher and lower open porosity than grade A. There were two exceptions where insufficient results were obtained to draw a conclusion. Analysis of the data confirmed that the open porosity is a rate-controlling parameter for the in-pile oxidation of graphite, and also extends them to graphites of higher porosity and oxidation in different atmospheres. (auth) (UK)

10285 THE REACTION OF O^- WITH ALCOHOLS IN GAS-PHASE RADIOLYSIS. Warman, John M. (Mellon Inst., Pittsburgh). Contract AT(30-1)-2310. J. Phys. Chem., 72: 52-6 (Jan. 15, 1968). (RRL-2310-198).

Addition of MeOH, EtOH, or i-PrOH to an alkane-N_2O (4%) mixture markedly increased the yield of nitrogen, $G(N_2)$, to a limiting value of $\sim 3G_e$ (where G_e is the yield of electrons). Addition of t-BuOH decreased $G(N_2)$ toward a value of $\sim G_e$. The results can be explained in terms of the reaction of the O^- ion (formed on electron capture by N_2O) with the alcohol. Two mechanisms for reaction appear to occur: one leading to products that can react with N_2O to give two molecules of N_2 (rate constant k_{O^-+ROH}), the other leading to products that do not react with N_2O (rate constant $k^*_{O^-+ROH}$). Using CO_2 as a competitive O^- ion scavenger, the rate constants k_{O^-+ROH} and $k^*_{O^-+ROH}$ were determined relative to $k_{O^-+CO_2}$. Possible reaction mechanisms are discussed. (auth)

10286 THE ^{60}Co γ RADIOLYSIS OF CYSTEINE IN DEAERATED AQUEOUS SOLUTIONS AT pH VALUES BETWEEN 5 AND 6. Wilkening, Verna Gaye; Lal, Manohar; Arends, Meta; Armstrong, D. A. (Univ. of Calgary, Alberta). J. Phys. Chem., 72: 185-90 (Jan. 15, 1968).

The major products arising from the ^{60}Co γ radiolysis of 10^{-2} M cysteine (CySH) solutions at pH's in the range from 5 to 6 are: cystine ($(CyS)_2$), alanine (CyH), H_2S, and hydrogen with yields of 3.4, 2.6, 2.5, and 1.1 molecules/100 eV, respectively. The reactions, which were proposed independently by El Samahy, White, and Trumbore and Armstrong and Wilkening in 1964, are consistent with the results. Nitrate ions and acetone repress the alanine and H_2S yields by identical amounts. This and other observations indicate that: $G_{e_{aq}^-} = 2.5 \pm 0.2$ in 10^{-2} M cysteine solutions; reaction 4, $e_{aq}^- + CySH \rightarrow Cy + SH^-$, is the only significant reaction of e_{aq}^- with cysteine at pH 5 to 6; and that all Cy radicals undergo reaction 5, $Cy + CySH \rightarrow CyH + CyS$. The product of the reaction between e_{aq}^- and nitrate oxidizes two cysteine molecules to cystine with the concomitant formation of nitric oxide. In the pH range employed, reaction 8, $H_2O_2 + 2CySH \rightarrow 2H_2O + (CyS)_2$ is relatively slow and as a consequence there is a postirradiation oxidation of cysteine. (auth)

10287 ENERGY TRANSFER IN RADIOLYSIS OF RARE GAS-C_2F_6 LIQUID MIXTURES. Sokolowska, Alicja; Kevan, Larry (Univ. of Kansas, Lawrence). Contract AT(11-1)-1528. J. Phys. Chem., 72: 253-6(Jan. 15, 1968). (COO-1528-16).

The liquid-phase γ radiolysis of C_2F_6 with Xe, Kr, and Ar was investigated as a function of the fraction of energy deposition in the rare gas in the presence and absence of O_2 as a radical scavenger. All energy-transfer efficiencies were smaller by a factor of 2 to 3 than those found previously in the gas phase. The energy-transfer efficiencies in the absence of O_2 were similar for Xe and Ar, and twice as great for Kr. It is suggested that this reflects the correspondence between ionic states of Kr_2^+ and $C_2F_6^+$, and that charge transfer contributes to the energy-transfer process. In the presence of O_2, no energy-transfer contribution to nonscavengeable products was observed; this implies that excitation transfer processes are inefficient or are quenched by O_2. (auth)

10288 POLYMERIZATION OF N-VINYLPHTHALIMIDE BY γ-RAY RADIATION. Murata, Kenichi (Government Industrial Research Inst., Osaka). J. Polym. Sci., Part A-1, 5: 2942-5 (Nov. 1967).

The gamma-radioinduced polymerization of N-vinylphthalimide (VPI) in solid and solution states was studied. The polymerization of N-vinylsuccinimide (VSI) was carried out for comparison purposes. Solid VSI was easily polymerized; solid VPI was not. VSI polymer crystals were insoluble or merely swollen by several solvents; VPI polymer crystals were soluble in the solvents which included N,N-dimethylformamide (DMF), chloroform, acetylene tetrachloride, and ethylene dichloride. Results indicated that the polymer crystals of VPI are not crosslinked, unlike those of VSI. Results of x-ray diffraction studies are presented. The gamma radioinduced polymerization of VPI in DMF was easily carried out. (J.G.B.)

10289 AN IMPROVED METHOD FOR THE PRODUCTION OF ^{131}I FROM PILE IRRADIATED TELLURIUM. Murthy, T. S.; Nair, V. C. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem., 5: 337-9(July 1967).

The method involves dissolution of tellurium in the cold in a mixture of hydrogen peroxide and sodium hydroxide followed by acidification with sulfuric acid (6N) and subsequent distillation of ^{131}I. Spectrographic analysis of the product satisfies specifications of the isotope for oral administration in medicine. (auth)

10290 INFLUENCE OF THE SOLVENT AND RADIATION ON THE EXCHANGE KINETICS IN COMPLEXES OF BIVALENT PLATINUM. Grinberg, A. A.; Nikol'skaya, L. E.; Saprikova, N. M. Radiokhimiya, 9: 589-601(1967). (In Russian).

Cl and Br exchange in the systems: $[(C_3H_7)_2NH]_2[PtCl_4] + (C_3H_7)_2NH^{36}Cl$-acetone and $[(C_3H_7)_2NH]_2[PtBr_4] + (C_3H_7)_2NH^{82}Br$-acetone and interspherical exchange of thiocyanate between trans-$[Pt(NH_3)_2(^{35}SCN)_2]$ and $K_2[Pt(SCN)_4]$ and between cis-$[Pt(NH_3)_2(^{35}SCN)_2]$ and $K_2[Pt(SCN)_4]$ were studied in aqueous and acetone solutions. The rate of isotopic exchange of the ligands in chloro-, bromo-, and thiocyanoplatinates is far lower in acetone than in aqueous solutions at the same temperature and concentrations. The retardation is especially marked for interspherical exchange between cis- and trans-diamminodibromides of platinum and thiocyanoplatinite. The order of the anions as regards the rate of exchange remains the same in acetone as in aqueous solutions, $Cl^- < Br^- < SCN^-$, but the difference between them is smoothed out. The concentration dependences of the rates of exchange indicates that the principal exchange mechanism is a bimolecular nucleophilic substitution. Ionizing radiation from ^{82}Br and ^{60}Co affected the exchange rate of chloro- and bromoplatinites in acetone. A solvent effect appeared in the absorption spectra of the chloro- and bromoplatinites. In acetone solutions the changes of those spectra with time were similar to those resulting from gamma radiation. (JPRS)

10291 THE REACTION OF ACETYLENE WITH γ RADIATION UNDER PRESSURE. II. Yashiro, Dairokuto; Naito, Teruyuki (Government Chemical Industrial Research Inst., Tokyo). Tokyo Kogyo Shikensho Hokoku, 62: 91-5(Mar. 1967). (In Japanese).

Acetylene was polymerized by ^{60}Co γ irradiation under pressure over the range from 3.5 to 16 atm (abs) and in the temperature range from 30 to 100°C. The value of $G(-C_2H_2)$ for the overall reaction was nearly constant in this range (~80), whereas $G(C_6H_6)$ decreased from 15 to 6 with increasing acetylene pressure, and $G(-C_2H_2)$ for polymer formation increased from 25 to 60 with increasing pressure. The apparent activation energy for both reactions was very small, and the rates were proportional to the 0.8th order of the dose rate. $G(C_6H_6)$ was not influenced by variation of the surface-volume ratio of reaction vessel. G(diacetylene) was less than 1 and ~ proportional to $G(C_6H_6)$ in the range studied. (BBB)

10292 GAMMA-RAY INITIATED REACTIONS. THE ADDITION OF TRIPHENYLSILANE TO SIMPLE ALKENES. El-Abbady,

A. M. (Ainshams Univ., Cairo). J. Chem. U.A.R., 9: 281-5 (1966).

Triphenylsilane was found to add successfully to simple open chain and cyclic alkenes as 1-octene and cyclohexene under the influence of γ rays from ^{60}Co as initiator. The yields of the corresponding adducts were very low. The expected adducts were found to be the saturated monomers triphenyl-1-octylsilane and triphenylcyclohexylsilane, respectively. In addition to these adducts a very small amount of another crystalline product was separated and found to be hexaphenyldisiloxane $(C_6H_5)_3SiOSi(C_6H_5)_3$. This silane ether may be formed during the separation of the reaction product by the action of the solvent of crystallization (ethanol) on the unreacted triphenylsilane. Reversing the molecular ratio of the reactants in case of 1-octene did not increase the yield of the adduct to a considerable extent. The ir spectrum of triphenyl-1-octylsilane showed strong bands at 1440, 1120, 740, and 700 cm^{-1}, characteristic of the stretching frequencies of the Si-phenyl doublet, and the bending frequencies (out-of-plane) of 5 adjacent free hydrogen atoms, respectively. The structure and chemical constitution of this product was confirmed by its identity (mp, and ir spectrum) with an authentic sample of triphenyl-1-octylsilane. Although the structure of the adduct obtained from the reaction of triphenylsilane and cyclohexene was not proven, it is presumed that its formula is $(C_6H_5)_3SiC_6H_{11}$. It is concluded that under γ-induced imitation, triphenylsilane is added by a free-radical mechanism to the ethylenic linkage of 1-octene and cyclohexene, the products formed being the saturated monomeric adducts. (BBB)

10293 RADIATION-INDUCED cis AND trans ISOMERIZATION OF POLYISOPRENES AND TEMPERATURE DEPENDENCE OF THE EQUILIBRIA. Tsurugi, Jitsuo; Fukumoto, Tsugio; Yamagami, Masayuki; Itatani, Hiroshi (Radiation Center of Osaka Prefecture, Sakai, Japan). Rubber Chem. Technol., 40: 1222-9(Sept. 1967).

A pale crepe (hevea) and gutta percha were used as cis-1,4- and trans-1,4-polyisoprene, respectively, to study the cis and trans interconversion of polyisoprenes in benzene solution induced by γ rays in the presence of a sensitizer (an organic bromide or a mercaptan). Sensitized solutions were irradiated in air at room temperature with a ^{60}Co source. The resulting polymer structures were determined by ir absorption measurements. The equilibrium constants for the interconversion at 22, 60, and 100°C were found to be 3.00, 5.25, and 7.33, respectively. The first-order rate constants for cis → trans and trans → cis isomerizations at 22°C were calculated to be 9.05 and 2.91, respectively. The results were interpreted by the mechanism proposed by Golub, according to which the double bonds from π complexes with radiolytic fragments from sensitizers give a radical transition state capable of interconversion. However, the results showing that heating shifts the equilibrium toward trans isomer were not in accord with the mechanisms of the radioinduced isomerization of polybutadiene of Golub and those of photoisomerization of aromatic azo compounds. (BBB)

10294 EFFECT OF ^{60}Co γ RADIATION ON PURE DIMETHYLMERCURY AND DIETHYLMERCURY AND THEIR BENZENE SOLUTIONS. Heitz, Charles (Centre de Recherches Nucleaires, Strasbourg-Cronenbourg, France). J. Organometal. Chem. (Amsterdam), 8: 401-10(June 1967). (In French).

Free radical mechanisms involved in the radiolysis of these alkylmercury compounds were studied at radiation doses up to 6×10^{21} eV/cm^3. The hydrocarbons formed were measured by gas chromatography, and the free radicals by the rate of disappearance of diphenylpicrylhydrazyl. After irradiation of dimethylmercury and diethylmercury in pure form the radiolysis products were metallic mercury, methane, and ethane. Diethylmercury also yielded butane, and the benzene solutions yielded toluene, ethylbenzene, and ethylene. On the basis of radical yields measured with DPPH, mechanism schemes are proposed. The alkyl radicals (R') formed reacted with the alkylmercury compounds ($R^{\cdot} + R_2Hg \rightarrow R_3 + R^{\cdot} + Hg$) and with each other ($2R^{\cdot} \rightarrow R_2$). (BBB)

10295 STUDIES ON THE RADIATION DAMAGE OF CATION EXCHANGER 1. El-Guebeily, M. A.; Souka, N. (UAR Atomic Energy Establishment, Inshas). J. Chem. U.A.R., 8: 269-74 (1965).

The effect of β and γ radiation from ^{137}Cs on Merck Cation Exchanger 1, which is a polystyrene derivative with nucleosulfuric acid groups, mesh 0.4 to 0.6 mm, was studied. The H^+ capacity of the nonirradiated resin sample was found to be equal to 3.85 meq/g. The reduction in the capacity of the irradiated samples for the following doses was: 3.17, 4.72, and 11.38% for 21, 30, and 150 kR of γ radiation and 13.55% for a combined dose of 230 kR γ and 3.6×10^{18} eV/β radiation. Effluent from samples nearest the ^{137}Cs source had a yellow color and that this color became fainter the smaller the dose. This color was probably due to radiation decomposition products of the resin. It was clear that Cation Exchanger 1 undergoes radiation damage in the investigated dose range, and that this damage is manifested by a decrease in the capacity of the resin. The capacity loss increased with dose. The observed damage may be attributed to direct or indirect excitation and ionization, which probably leads to rupture of chemical bonds involving active groups of the resin. The comparatively low radiation stability of Cation Exchanger 1 may be due to a lower degree of crosslinking. This concept is concordant with other results indicating that the internal diffusion coefficient of ^{95}Zr is much higher in this resin than in other cation exchange resins, a fact possibly due to larger pores in Cation Exchanger 1. (BBB)

10296 RADIATION-INDUCED POLYMERIZATION OF p-HALOSUBSTITUTED STYRENE. Yamaoka, Hitoshi; Nishiyama, Katsuo (Kyoto Univ.). Kobunshi Kagaku, 24: 649-54(Oct. 1967). (In Japanese).

The γ-induced polymerization of p-chlorostyrene (Cl−St) and p-bromostyrene (Br−St), and the copolymerizations of these monomers with styrene (St) were studied in methylene chloride solution. In the polymerization of Cl−St at 9°C, the kinetic order of the rate of polymerization (R_p) was 0.47 in reference to the dose rate. The value ϕ_{rel} ($=\phi_s/\phi_m$), which expresses the relative ratio of free radical production in the solvent and in the monomer, was determined as 5.4 from the effect of the monomer concentration on R_p. On the other hand, in the polymerization at −78°C, R_p was linearly proportional to the dose rate and the polymerization was strongly retarded by the addition of diethylamine (DEA). In the copolymerization of Cl−St with St, the monomer reactivity ratios (MRR) at 9°C were almost same as those obtained by conventional radical initiators and MRR at −78°C coincided with those obtained by cationic catalysts. When copolymerized at −40°C, the intermediate values of MRR between those at 9 and −78°C were obtained. Similar results were also obtained in the polymerization of Br−St and the copolymerization of Br−St with St. From these results, it was concluded that the polymerizations at 9 and −78°C proceed by radical and cationic mechanisms, respectively, and that both mechanisms were simultaneously operative at −40°C. (NSA of Japan)

10297 PHOTOLYSIS AND RADIOLYSIS OF SOME SIMPLE NITROALKANES. I. NITROMETHANE. Paszyc, Stefan (Univ., Poznan, Poland). Bull. Soc. Amis Sci. Lett. Poznan, Ser. B., 18: 1964/65, 5-17(1965).

Prolonged photolysis of nitromethane in both the vapor and liquid states, with simultaneous photolysis of the evolving nitrogen dioxide to atomic oxygen and nitric oxide was investigated. Photolysis of the compound in vapor state was conducted in a specially assembled apparatus using a quartz immersion lamp with the full range of both the visible and ultraviolet spectrum especially rich in radiation of wavelengths 366 and 313 mμ. The products of photolysis were detected by way of a microanalytical reaction, recording the spectra in infrared, and by gas chromatography. Photolysis of nitromethane in the presence of cupric oxide and zinc oxide was also conducted. A mechanism is proposed from the photochemical decay of the compound. Liquid nitromethane was exposed to ^{60}Co γ radiation and a number of products were obtained. A probable mechanism of their formation is proposed. (auth)

10298 PHOTOLYSIS AND RADIOLYSIS OF SOME SIMPLE NITROALKANES. II. NITROETHANE. Paszyc, Stefan (Univ., Poznan, Poland). Bull. Soc. Amis Sci. Lett. Poznan, Ser. B, 18: 1964/65, 19-28(1965).

Photolysis of nitroethane in the vapor and liquid state as well as radiolysis in the liquid state were carried out. Particular attention was devoted to investigation of the liquid systems. Photolysis of nitroethane vapor was carried out in specially assembled glass apparatus by introducing an immersion quartz lamp rich in radiation of wavelengths 366 and 313 mμ. The products of photolysis and radiolysis of the compound were analyzed by gas chromatography and infrared spectrophotometry. Analysis of the products of liquid nitroethane resulted in the detection of propane and i-butane not found as yet. Photolysis was also carried out in the presence of cupric oxide. Radiolysis of liquid nitroethane yielded a number of products, both liquid and gaseous, among which simple saturated hydrocarbons prevailed. The mechanism of formation of products by prolonged photolysis and radiolysis of nitroethane is discussed, as well as the role of oxygen evolving in the photolytic decomposition of NO_2. (auth)

10299 MECHANISM OF RADIATION POST-POLYMERIZATION OF TRIOXANE. Trofimova, G. M.; Berlin, Al. Al.; Barkalov, I. M.; Kuz'mina, S. S.; Gol'danskii, V. I.; Enikolopyan, N. S. (Inst. of Chemical Physics, Moscow). Vysokomol. Soedin., Ser. A, 9: 2321-8(Nov. 1967). (In Russian).

Post-polymerization of trioxane preirradiated with doses 0.013

to 0.45 MRAD has been studied at 30 to 64°C. The kinetic curves above 45°C have two regions with different rates: the leap with the rate more than 100%/hr and slope with the rate 5 to 30%/hr. The values of the leaps do not depend on the temperature and are proportional to the dose of preirradiation. The rates in the second region are proportional to the dose and have the activation energy $E_\alpha \simeq 35$ kcal/mole. (auth)

10300 MODIFICATION OF ADHESION BEHAVIOR OF SYNTHETIC FIBERS BY RADIATION GRAFTING OF FLUOROOLEFINS. Kurilenko, A. I.; Nikulina, I. G.; Danilov, E. P. Vysokomol. Soedin., Ser. A, 9: 2376-80(Nov. 1967). (In Russian).

Graft polymerization of hexafluoropropylene (C_3F_6) and chlorotrifluoroethylene (C_2F_3Cl) on oriented polypropylene, polyethylene terephthalate and polycaproamide fibers was carried out by direct γ rays of ^{60}Co exposition in the monomer vapor. Adhesion to poly(vinyl alcohol) and wetting with increase of the grafted polymer decreased to certain limit depending on the fiber nature. The results on the surface behavior were explained with adsorption theory of adhesion. (auth)

10301 RADIOLYTIC ISOMERIZATION OF STILBENE IN SOLID SYSTEMS. Fischer, E. (Weizmann Inst. of Science, Rehovoth, Israel); Fischer, Gabriella; Stein, G. Israel J. Chem., 5: 213-22(Sept.-Oct. 1967).

The γ-induced trans → cis isomerization of stilbene was investigated in solutions in the frozen organic solvents benzene, toluene, naphthalene, dibenzyl, and cyclohexane, and compared with fluid solutions in the same solvents, at appropriate temperatures. In dilute (up to 10^{-2}M) solutions in benzene isomerization took place in the frozen system at a higher rate than in the corresponding fluid system, with the ratio between these rates increasing with decreasing stilbene concentration. These results indicate that energy transfer in frozen benzene, and to stilbene embedded in it, takes place by a more efficient mechanism than the diffusional one operative in fluid solutions. It is suggested that singlet or triplet excitons are responsible for energy transfer within the microcrystals of the frozen benzene, and to stilbene molecules situated in specific (possibly surface) sites. At stilbene concentrations in the range 5×10^{-5} to 10^{-1}M G(trans → cis) in the frozen solutions is approximately constant (≈0.7), corresponding to G(excited stilbene) ≃ 1.4. This result is compatible with a mechanism involving efficient "harvesting" of all triplet benzene molecules in the solid under these conditions. Dilute solutions in toluene behave in a similar way, but no radiolytic isomerization takes place in solutions in solid naphthalene or dibenzyl, and also not in solid trans stilbene. (auth)

10302 YIELD OF AVAILABLE RADICALS IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. Marketos, Dennis G. (Democritos Nuclear Research Center, Athens); Rakintzis, Nikolaus Th.; Stein, Gabriel. Israel J. Chem., 5: 239-41(Sept.-Oct. 1967).

Dilute (2 to 3×10^{-5} M) aqueous solutions of Safranine T, (S), was used to investigate the yield of OH radicals in γ-radiolysis, at a dose rate of $\sim 6 \times 10^{-2}$ RAD/min. Four equivalents of OH were used up in the oxidative radiolytic decoloration of (S). As the pH decreased from >3 to <2, G(OH) appeared to increase from $\sim 4 \times 0.65 = 2.6$ to $\sim 4 \times 0.8 = 3.2$. Other experiments showed that in deaerated solutions this pH-dependent apparent increase also occurred; that the apparent increase was not due to H_2O_2 formed during the irradiation; that competitors for OH radicals competed with (S) for the species responsible for the additional yield in about the same ratio as for OH radicals; and that the increase in apparent OH yield was accompanied by an increase in $G(H_2O_2)$ that also has the value of ~0.6. Results showed that the increase was of a definite limited extent and occurred at a relatively low acid concentration. (D.H.M.)

10303 THE FORMATION MECHANISMS OF HYDROGEN PEROXIDE IN TITANIUM SULFATE–OXALIC ACID SYSTEM BY THE GAMMA-RAY IRRADIATION. Hasegawa, Kunihiko (Shizuoka Univ., Japan). Radioisotopes (Tokyo), 16: 428-33 (Sept. 1967). (In Japanese).

The formation mechanisms of hydrogen peroxide in titanium sulfate–oxalic acid system by ^{60}Co gamma irradiation was investigated. The radiation yields of hydrogen peroxide formed were measured at titanium ion concentrations (1×10^{-3} to 1×10^{-2}M) and oxalic acid concentrations (1×10^{-3} to 1×10^{-1}M) in 0.8 N sulfuric acid solution. The results obtained were quantitatively consistent with simple reaction schemes for determination of hydrogen peroxide in oxygen gas-saturated system. The hydrogen peroxide yields in the system are attributed to the recombination of OH radical in the spur and the radiolysis of oxalic acid. (auth)

10304 ^{60}Co-γ RADIOLYSIS OF AQUEOUS FERRO- AND FERRICYANIDE SOLUTIONS. Ohno, Shin-ichi; Tsuchihashi, Gen-ichi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 16: 434-8(Sept. 1967). (In Japanese).

Aqueous ferro- and ferricyanide solutions of various pH values were irradiated with ^{60}Co γ rays; effects of the added radical scavengers, N_2O and CH_3OH, on the yields of an aquated product, $[Fe(CN)_5OH_2]^{3-}$, as well as the oxidized or reduced product, were investigated. Possible mechanisms by which the aquated product is given are discussed. It was concluded that the reaction scheme in the ferro- and ferricyanide systems is not so simple as generally accepted and therefore the system is not suitable for measurements of the yields of intermediates in the radiolysis of water. (auth)

10305 MECHANISM OF THE FORMATION OF FREE RADICALS IN THE RADIOLYSIS OF SOME VINYL MONOMERS IN THE SOLID PHASE. I. ACRYLONITRILE AND α-CHLOROACRYLONITRILE. Marx, Rose; Fenistein, Serge (Faculte des Sciences, Orsay, France). J. Chim. Phys., 64: 1424-9(Oct. 1967). (In French).

ESR spectra of γ-irradiated acrylonitrile and α-chloroacrylonitrile in a matrix of aluminosilica powder were studied at 77 and 4.2°K. The observation of a vinyl type radical: $CH_2 = \dot{C} - CN$ in the chloro derivative only was consistent with the hypothesis of an ionic mechanism for the production of free radicals in both compounds. (auth)

10306 RADIATION EFFECTS ON THE PHYSICAL AND MECHANICAL PROPERTIES OF POLYMERS. Tynnyi, A. N.; Velikovskii, A. A. (Lvov Physicomechanical Inst., USSR, Inst. of Physics, Kiev). Fiz. Khim. Mekh. Mater., 3: 602-18 (1967). (In Russian).

A brief review is given on radiation effects on physical and chemical properties of polymers. Radiochemical processes in irradiated polymers and their influence on mechanical and physical properties are discussed. Graphical data are given on the dependence of elasticity and strength of polyethylene and caprone on radiation dose. Radioinduced reversible and irreversible changes were observed in stressed polymers that reduce the durability of materials. Effects of these processes on the durability of materials depend on the structure of the polymer, the degree of stress, radiation intensity, absorbed dose, and type of radiation. (97 references). (R.V.J.)

10307 RADIOLYSIS OF DILUTE AERATED SULFURIC ACID SOLUTIONS WITH 5.3-MeV ALPHA PARTICLES. Mariano, M. H.; Santos, M. L. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). Radiat. Res., 32: 905-14(1967).

The hydrogen peroxide yield in aerated sulfuric acid solutions, irradiated with 5.3-MeV α particles, was measured as a function of the acid concentration in the range from 5×10^{-3} to 1 M H_2SO_4. It was found that the curve $G(H_2O_2)$ versus $[H_2SO_4]$ presents a maximum, $G(HO_2) = 1.56$, for $[H_2SO_4] = 5 \times 10^{-2}$ M. From comparison of this curve with that obtained with similar solutions containing 10^{-4} M KBr, it was concluded that sulfuric acid interferes both with reactions taking place in the bulk of the solution (by scavenging of OH radicals) and with intratrack phenomena (through reaction between e^-_{aq} and H_3O^+ ions). The results indicate that the formation of sulfate radicals is repressed by some mechanism. For the interpretation of these results the existence of some such reaction as $SO_4^{--} + OH + H^+ \simeq SO_4^- + H_2O$ is considered. (auth)

10308 GAMMA RADIOLYSIS OF CARBON TETRACHLORIDE AND AMMONIA SOLUTIONS. Davis, Douglas Dale. Gainesville, Fla., Univ. of Florida, 1966. 103p.

Thesis.

A study of the gamma radiolysis of solutions of carbon tetrachloride and ammonia showed that the major products formed are ammonium chloride, ammonium dicyanamide, and hexachloroethane. The G values for these products are 25.3, 2.36, and 2.13, respectively. Other radiolysis products include cyanoguanidine, guanidine hydrochloride, and nitrogen. They are formed with G value yields of 0.48, 0.53, and 0.80, respectively. These observations together with those from several related studies (e.g., high pressure mass spectrometry, UV photolysis, microwave induced decompositions, radical scavenger experiments, and studies on the thermally induced reactions of cyanogen bromide and ammonia) led to the following conclusions concerning the γ radiolysis of carbon tetrachloride–ammonia solutions: the large G value of ammonium chloride does not indicate a chain process but merely reflects the stoichiometry of the reaction; trichloromethylamine, dichloromethyleneimine, cyanogen chloride, and cyanamide are all chemically reactive intermediates which are part of a reaction sequence leading to the formation of the organic nitrogen com-

pounds; both ionic and free radical processes lead to the formation of trichloromethylamine; and the absence of hydrazine as a major radiolysis product is due to secondary reactions involving NH_2 radicals. (Disser. Abstr.)

10309 EFFECT OF WATER ON THE KINETICS AND DIFFUSION IN RADIATION GRAFTING OF ACRYLONITRILE TO CELLULOSE. Walsh, William Kershaw. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 126p.
Thesis.

The characterization of the grafting of acrylonitrile to cotton and rayon, especially in regard to the way water affects the rate of grafting, was investigated. It was found that variations in the water content of the fibers affects the amount of acrylonitrile adsorbed at equilibrium, the rate of diffusion of acrylonitrile into the fibers, and the rate of polymerization of the monomer inside the fibers. The grafting was carried out in two ways, pre-irradiation grafting and mutual irradiation grafting. In the former case, the fibers were pre-irradiated for a fixed time in dry nitrogen, and then flushed, without irradiation, with nitrogen containing various amounts of acrylonitrile and water vapor. The subsequent grafting was followed for 24 hrs by analyzing the yarns for polymer, monomer, and water at various intervals. Mutual grafting was carried out by simultaneous irradiation and monomer flushing. Grafting rates in all cases were higher for higher water vapor concentrations. The decay of the radicals produced by the pre-irradiation dose was applied to a kinetic model which required both first-order and second-order radical termination to fit the data. The apparent first-order termination was discussed in terms of occlusion and burial of radicals by polymer. Calculated values for the first-order termination constants and the ratios of the second-order termination constant to the polymerization (chain propagation) constant (k_t/k_p) did not vary appreciably with the water content of the fibers. First-order termination was the same for both fibers, but k_t/k_p was higher for rayon than for cotton. The increased grafting rates at high water vapor concentrations was explained by increased mobility and diffusion and subsequent higher values of k_p and k_t, though their ratio remained constant. Highly restricted second-order termination was indicated by values of k_t/k_p of five orders of magnitude less than that obtained in aqueous solution. During mutual irradiation grafting, the value of k_pR = (dP/dt)/M was very high at first, but decreased rapidly, as polymer began forming, and finally became constant at a value nearly linearly proportional to the fiber water content. The initial decrease in k_pR was attributed to radical burial and decreased radical availability with polymer buildup. A solution to the equation for diffusion with simultaneous chemical reaction was derived and used to calculate the diffusion constants for acrylonitrile into the fibers. It was found that, below about 60% relative humidity, diffusional resistance, coupled with polymerization, limited the monomer content of the fibers to about one-half the equilibrium value. The diffusion constant was about $(1.5 \pm 1.0) \times 10^{-11}$ cm^2/sec in this humidity range and did not vary appreciably with water content. The variation in monomer content with water content was attributed to variations in its equilibrium value and not to changes in the diffusion constant. Above 60% relative humidity the diffusion constant was greater than 3×10^{-10} cm^2/sec and grafting took place with monomer concentration at its equilibrium value, with grafting rate controlled only by the value of k_pR. (Disser. Abstr.)

10310 SOME STUDIES OF THE IONIZING RADIATION-INDUCED ISOTOPE EXCHANGE IN GASEOUS NITROGEN. Brown, Robert D. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 167p.
Thesis.

The gas-phase isotopic exchange of $^{14}N_2$ with $^{15}N_2$ under ionizing radiation was studied in a number of systems important to the radioinduced fixation of nitrogen. The results indicate that a mixture of $^{14}N_2$ and $^{15}N_2$ free of oxygen or other impurities undergoes isotopic exchange to form $^{14}N^{15}N$ with a G_N value of 11.5 ± 1.0. That is, 11.5 atoms of nitrogen are involved in the formation of isotopically mixed nitrogen molecules for every 100 eV of energy absorbed by the gas mixture. The mechanisms of this isotopic exchange are believed to be the random recombination of nitrogen and a type of molecular exchange. Experiments conducted at temperatures up to 400°C indicated that an ion chain mechanism of isotopic exchange was not operative. Experiments in which oxygen was added to the isotopic nitrogen mixture showed a decrease in G_N with increasing concentration of oxygen. At 1% oxygen concentration G_N was approximately one half its value in pure nitrogen. It appears that the primary role of oxygen is to remove nitrogen ions from the system by charge transfer thus preventing nitrogen atoms from forming as a result of ion recombination. Oxygen also appears to quench excited nitrogen molecules. Experiments were conducted using mixtures of either ^{15}NO or $^{15}NO_2$ in isotopically natural nitrogen. G_N was found to be 2.0 to 2.6. This range of G values represents the actual number of nitrogen atoms formed by dissociative excitation of nitrogen per 100 eV absorbed. Similarly conducted experiments in which isotopically natural nitric oxide or nitrogen dioxide was added to a mixture of $^{14}N_2$ and $^{15}N_2$ showed G values 2.0 to 2.5 units higher than those in which the oxide was labeled. It is believed that this increase represents the G value for the molecular types of isotopic exchange. The results obtained from the irradiation of mixtures of $^{14}N_2O$ and $^{15}N_2O$ were utilized in developing a new method for determining the thermal neutron component of a mixed radiation field. These same experiments showed that nitrous oxide is reformed during its decomposition and confirmed that $N_2O \rightsquigarrow N_2 + O$ is the primary step of the radiation induced decomposition. Mixtures of each of the rare gases with nitrogen were also irradiated. The mechanisms of isotopic exchange in these mixtures are undoubtedly very complicated and may even be specific for each mixture. For the helium–nitrogen mixture it was found that the isotopic exchange was greater than in pure nitrogen. This may be important for the radiation induced fixation of nitrogen if it can be shown that the increased exchange is the result of an increased number of nitrogen atoms being formed. (Disser. Abstr.)

10311 METHOD FOR PRODUCING A PERFUME WITH IONIZING RADIATION. Kinoshita, Shosaku. Japanese Patent 1966-20239. Nov. 25, 1966. Filed Feb. 21, 1964.

Irradiation of liquid isoamyl salicylate with ionizing radiation, such as γ rays, to a dose of 1×10^6 to 5×10^6 R remarkably increases the green note, i.e., fresh-and-live plant fragrance. (TSS)

10312 RADIATION-INDUCED COLOR CENTERS IN AROMATIC CRYSTALS. Katul, Jamil A. Durham, N. C., Duke Univ., 1967. 99p.
Thesis.

Seven aromatic solids, fluorene, dibenzofuran (di-O), dibenzothiophene (di-S), naphthalene, carbazole, indole, and thianaphthene, were zone-refined (10 to 200 zones), and gamma-irradiated (5×10^6 R) to induce color centers. All the irradiated crystals acquired a light amber yellow color except carbazole, which turned greenish. The reflection and the luminescence spectra of the color centers were photographed at room temperature (RT) and at 77°K on a medium Bausch and Lomb spectrograph. The spectra did not undergo observable change after long time storage (~2 years) of the crystals at RT in room light. They were stable also under exposure to condensed visible or uv light for several days. However, they got weaker, to a greater or less extent, on heating and disappeared completely on melting of the crystals. The color center spectra of indole and thianaphthene consisted of few very weak and diffuse lines. All the other compounds had spectra with many lines, and each spectrum had a particularly sharp 0-0 absorption line coinciding, within the experimental error, with a sharp 0-0 emission line. They also possessed a common vibration around 1500 cm^{-1}. This is in addition to spectral resemblances within the pairs: fluorene and di-O, di-O and di-S, naphthalene and carbazole. However, the ESR spectra of the colored crystals indicated the presence of free radicals only in carbazole. Based on theoretical considerations and experimental findings, it was concluded that unstable association molecular products (unidentified) would account for the observations better than F-centers, ions or free radicals. Further irradiation studies at liquid nitrogen temperature and of doped crystals were suggested to investigate more thoroughly the role of free radicals and the possible presence of some suspected impurities. (Disser. Abstr.)

10313 METHOD FOR IMPROVING PERFUME WITH IONIZING RADIATION. Kinoshita, Shosaku. Japanese Patent 1966-20240. Nov. 25, 1966. Filed Feb. 21, 1964.

By the proposed method, employing ionizing radiation, the fragrance and green note of the perfume, a condensation product of methyl anthranilate and hydroxycitronellal, can be remarkably increased. The condensation product is irradiated with ionizing radiation such as gamma rays (from a radioisotope) or accelerated electrons (from a linear accelerator) to a dose of 10,000,000 to 5 × 10,000,000 R. (NSA of Japan)

10314 PROCESS FOR THE PRODUCTION OF POLYETHYLENE. Imhausen, Karl-Heinz; Renner, Hans Joachim (to Bochumer Chemie Imhausen Co., mbH). British Patent 1,096,968. Dec. 29, 1967. Filed Sept. 29, 1966.

A process for continuously producing polyethylene comprises subjecting ethylene to polymerization at a pressure of from 1000 to 3000 atm and at a temperature of from 150 to 300°C in the presence of O_2 and at the same time subjecting the mixture to γ radiation. (B.L.M.)

10315 ACTION OF IONIZING RADIATION ON ION-EXCHANGE MATERIALS. Egorov, E. V.; Novikov, P. D. New

York, Daniel Davey and Co., Inc., 1967. 260p. $16.50. (IPST-Cat.-2184).

Translation of Deistvie Ioniziruyushchikh Izluchenii na Ionoobmennye Materialy by J. Schmorak.

The following topics are discussed: properties of ion exchange materials; certain problems in radiation chemistry; effects of ionizing radiation on cation and anion exchange resins and other ion exchange materials; and, mechanisms of radiochemical transformations in ion exchange resins. Also included are brief descriptions in tabular form of ion exchange materials and a synopsis of experimental data of the effects of ionizing radiation on ion exchange materials. (J.G.B.)

Radiochemistry

Refer also to abstracts 10349 and 10517.

10316 ISOTOPIC EXCHANGE OF 1,1-DICHLOROETHANE AND 1,2-DICHLOROPROPANE WITH LITHIUM CHLORIDE. Bantysh, A. N.; Zel'venskii, Ya. D.; Shalygin, V. A. Radiokhimiya, 9: 511-14(1967). (In Russian).

The isotopic exchange between 1,1-dichloroethane and 1,2-dichloropropane with lithium chloride in methanol was studied at different concentrations and concentration of the reagents. It was found that the reactions are bimolecular. The energies of activation and preexponential common multiples were calculated. The data indicate a significant spatial difficulty for the isotopic exchange reaction with 1,1-dichloroethane. The isotopic exchange reactions of $Li^{36}Cl$ with 1,1-dichloroethane and 1,2-dichloropropane can be used as a convenient method for the preparation of 1,1-$C_2H_4{}^{36}Cl_2$ and 1,2-$C_3H_6{}^{36}Cl_2$. (tr-auth)

10317 STUDY OF THE INTERACTION OF RADIOACTIVE MICROCOMPONENTS IN AQUEOUS SOLUTION WITH ALKYLARYLSULFONIC ACID BY THE FOAM FORMATION METHOD. I. NATURE OF THE BONDS OF ^{90}Sr, ^{90}Y, AND ^{144}Ce WITH ALKYLARYLSULFONIC ACID. Pushkarev, V. V.; Berezyuk, V. G.; Khrustalev, B. N. Radiokhimiya, 9: 438-43(1967). (In Russian).

The interaction of radioactive ^{90}Sr, ^{90}Y, and ^{144}Ce in aqueous solution with alkylarylsulfonic acid was investigated by the extraction of radioactive microcomponents and surface-active substances in foam. It was found that the interaction of sulfonic acid with the isotopes proceeds by an exchange reaction of the hydrogen ions of surface-active substance on cations of the isotopes. (tr-auth)

10318 INVESTIGATION OF THE SELECTIVITY OF THE ADSORPTION AND DESORPTION OF CESIUM IN HYDROPHORE SURFACE-LIQUID SYSTEM WITH RESPECT TO THE $^{137}Ba/^{137}Cs$ RATIO AT THE ADSORBENT SURFACE. Glazunov, V. V.; Skul'skii, I. A. Radiokhimiya, 9: 403-8(1967). (In Russian).

Observations on the change of the γ activity of adsorbents (polyethylene and Fluoroplast-4) made it possible to evaluate the ratio of the isotopes $^{137}Ba/^{137}Cs$ on the surface and to investigate the selectivity of the adsorption and desorption processes. Ba was adsorbed better than Cs from aqueous solution. After extraction from solution, the γ activity of the samples decreased with the half-life of ^{137}Ba until the establishment of the radioactive equilibrium $^{137}Cs-{}^{137}Ba$ on the surface. Cs was adsorbed better than Ba from aqueous solutions of sodium tetraphenylborate. The γ activity of the samples after extraction increased up to the establishment of equilibrium. The inhibiting effect of tetraphenylborate on the desorption of Cs, adsorbed from aqueous solution, was caused by the conversion of the inorganic form of Cs on the surface into cesium tetraphenylborate which is selectively desorbed with dioxane and acetone. Barium is desorbed with several times more difficulty. After extraction from dioxane or acetone, the γ activity of the samples decreased during the measurement process because of the decay of the above-equilibrium quantity of ^{137}Ba on the surface of the adsorbent. (tr-auth)

Separation Processes

Refer also to abstracts 10254, 10317, 10648, 10936, 10937, and 12006.

10319 (BM-RI-7100) EXTRACTION BEHAVIOR OF CERIUM-GROUP LANTHANIDES IN A PRIMARY AMINE-CHELATING AGENT SYSTEM. Bauer, D. J.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center); Higbie, K. B. (Bureau of Mines, Washington, D. C.). Feb. 1968. 12p. Bureau of Mines Free.

A primary amine extraction system was investigated for fractionating a cerium-group, lanthanide sulfate mixture. Addition of diethylenetriaminepentaacetic acid (DTPA) to the amine extraction system resulted in separation factors as high as 5.4 for lanthanum-cerium, 8.0 for cerium-praseodymium, 3.7 for praseodymium-neodymium, and 7.0 for neodymium-samarium. In multistage studies on a cerium-free lanthanide mixture, 96% of the lanthanum was recovered with a purity of [illegible]. (auth)

10320 (CEA-R-3205) ETUDE DU COMPORTEMENT DE QUELQUES ELEMENTS LOURDS DANS DES SOLVANTS A BASE D'ACIDE FLUORHYDRIQUE. (Study of the Behavior of Some Heavy Elements in Solvents Containing Hydrogen Fluoride). Tarnero, Maurice (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1967. 71p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

The anhydrous liquid mixtures: dinitrogen tetroxide-hydrogen fluoride and antimony pentafluoride-hydrogen fluoride were studied as solvents for uranium, thorium, zirconium, and for some of their compounds. For N_2O_4-HF mixtures, electric conductivity measurements and liquid phase infrared spectra were also obtained. Uranium and zirconium tetrafluorides are much more soluble in N_2O_4-HF mixtures than in pure hydrogen fluoride. Uranium dissolved in these mixtures is pentavalent. In SbF_5-HF mixtures, uranium dissolved with hydrogen evolution and became trivalent. The solid compound resulting from the dissolution was a fluoroantimonate: $U(SbF_6)_3$. (auth)

10321 (EURAEC-1938) THE REPROCESSING OF IRRADIATED FUELS GAMMA AND NEUTRONS PROTECTION CALCULATIONS. Topical Report No. 9. Servais, F. (Societe Belge pour l'Industrie Nucleaire, Brussels). Oct. 1967. Contract 016-65-67. 27p. (EUR-3761). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The doses delivered by reprocessing vessels assumed filled with plutonium fluoride or oxide were calculated and the screen necessary for the biological shielding of personnel working near these vessels determined. The irradiated elements come from a 1000 MWe fast reactor; two representative isotopic compositions were selected, corresponding to separate recycling and simultaneous core and cover recycling. The quantity of plutonium envisaged is that contained in one assembly (17.64 kg). In the case where the operator works at a distance of one meter from the external surface of the vessel, the doses received in the absence of protective canning, apart from gamma due to residual fission products, are as follows: spontaneous fission neutrons, 6 to 9.5 mrem/hr; natural radioactivity gamma, 1.5 to 4 mrem/hr; spontaneous fission gamma, less than 0.4 mrem/hr; alpha neutrons (case of fluorides), 200 to 300 mrem/hr; and alpha neutrons (case of oxide), 1.5 mrem/hr. The sum of these doses can be reduced to less than 2.5 mrem/hr (safety limit) by means of protective screens made up of 9 cm (case of oxide) or 23 cm (case of fluorides) of paraffin, plus 0.5 to 2.5 cm of lead. If the residual fission product gammas are taken into account, additional lead is necessary. Its thickness is from 10 to 15 mm in the case of oxides, as well as in the case of fluorides with extensive decontamination (residual gamma activity in the region of 18 to 55 mCi/cm^3); it is from 35 to 40 mm in the case of fluorides with smaller decontamination (residual gamma activity from 200 to 700 mCi/cm^3). (auth)

10322 (KFK-603) STRAHLENDOSISLEISTUNG DES WIEDERAUFGEARBEITETEN Na 1 BRUETERBRENNSTOFFES. (Radiation Dose Rates of Reprocessed Na 1 Breeder Fuels). Zimmermann, H. (Kernforschungszentrum, Karlsruhe (West Germany)). July 1967. 20p. (In German). Dep.

The activity of reprocessed Na 1 breeder fuels was calculated. The fuel of the more highly enriched core zone 2 was considered as the more unfavorable case. The activity is composed of the γ activity of the fission products and the plutonium isotopes as well as their decay products and the neutron activity of the plutonium. It is dependent on the finished form. Common reprocessing of the core and blanket material is advantageous when it leads to a lower radiation source intensity than separate core processing. The fission product activity, as an example, was reduced by common processing to about 30%. The decontamination factor should be larger than 10^8, although it does not need to be larger than 10^7. The shielding consists of iron and paraffin. The required material thicknesses are dependent on the finished form, the amount of fuel, and the density of the fuel. (tr-auth)

10323 (LF-37) STUDY OF THE EXCHANGE CHARACTERISTICS OF MONTMORILLONITE CLAY FOR FISSION PRODUCT CATIONS FOR USE IN THE GENERATION OF INSOLUBLE AEROSOLS. Technical Progress Report. McKnight, Mary E.; Norgon, Russell W. E. (Lovelace Foundation for Medical Education

and Research, Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-2)-1013. 12p. Dep. CFSTI.

The exchange of cesium, cerium, strontium, and yttrium with exchangeable ions in montmorillonite clay in aqueous suspension was studied. The percent of the initial ion concentration exchanged into the clay was determined as a function of the initial concentration. These data are useful in the preparation of clay having a high specific activity. It was found that clay can be prepared that has a specific activity of 2 mCi per mg for ^{137}Cs and 6 mCi per mg for ^{91}Y and ^{144}Ce. (auth)

10324 (ORNL-TM-2058) MEASUREMENT OF THE RELATIVE VOLATILITIES OF FLUORIDES OF Ce, La, Pr, Nd, Sm, Eu, Ba, Sr, Y, AND Zr IN MIXTURES OF LiF AND BeF_2. Hightower, J. R. Jr.; McNeese, L. E. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

One step in processing the fuel stream of a molten salt breeder reactor is removal of rare earth fission product fluorides from the LiF–BeF_2 carrier salt by low-pressure distillation. For designing the distillation system relative volatilities of the fluorides of Ce, La, Pr, Nd, Sm, Eu, Ba, Sr, Y, and Zr were measured with respect to LiF, the major component. The measurements were made using a recirculating equilibrium still operated at 1000°C and at pressures from 0.5 to 1.5 mm Hg. Errors from several sources were estimated and shown to be small. (auth)

10325 (UCRL-Trans-10178) CONDITIONS FOR ISOTOPIC ENRICHMENT BY A PHOTOCHEMICAL REACTION. Gilbert, R. Translated by F. D. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from J. Chim. Phys., 60: 205-8(1963). 14p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

It is possible, by irradiation of a gas with a radiation belonging to its vibration spectrum, to obtain molecules whose vibration energy corresponds to a temperature above the translational temperature. Excitation of the vibrations of a molecule can greatly increase the rate of a chemical reaction. It follows that differences in the reaction rates of two isotopic molecular species may be expected under the influence of a radiation belonging to its vibration-rotation spectrum. (auth)

10326 PREPARATION OF NEARLY PURE ORTHO-HYDROGEN AND PARADEUTERIUM. Depatie, D. A.; Mills, R. L. (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 39: 105-7(Jan. 1968).

A simple device, based on preferential adsorption at 20°K, for preparing liter quantities of 99% orthohydrogen or paradeuterium is described and some typical results are given. A straightforward analysis explains the experimental results and suggests a mechanism of enrichment. (auth)

10327 PRELIMINARY INVESTIGATIONS OF ^{18}O ENRICHMENT BY THE WATER DISTILLATION METHOD IN A "POLPAK" PACKED VACUUM COLUMN. Selecki, Anatol; Bulanda, Jan (Institut Badan Jadrowych, Warsaw). Nukleonika, 12: 1027-36 (Nov. 1967). (In Polish).

A 6-meter packed vacuum column designed for investigation of the ^{18}O enrichment process by water and acid water solution distillation is described. The applied "polpak" packing, made of surface-hydrophylized polyethylene, showed during distillations under 200 mm Hg pressure and 70 kmol/m^{2}hr load. The determined relative volatility value of the system $H_2^{16}O - H_2^{18}O$ amounted, under research conditions, to 1.0054 ± 0.0001. (auth)

10328 SEPARATION OF TRACES OF ELEMENTS FROM LARGE AMOUNTS OF IRON BY ANION EXCHANGE. Danielsson, L. (Swedish Inst. for Metal Research, Stockholm). Ark. Kem., 27: 453-8(1967).

Adsorption on anion exchangers and elution were studied for Bi(III), Mo(VI), Nb(V), Sb(V), Sn(IV), Ta(V), Ti(IV), V(V), W(VI), and Zr(IV). The metals were held extremely strongly by Dowex 1 × 8 in 1N HF even in solutions containing 40 mg Fe(III)/ml. Trace amounts of these elements were successfully recovered after separation from 10 g of iron using a column containing 3 g of Dowex 1 × 8. (auth) (Sweden)

10329 SALTING OUT DURING EXTRACTION OF THORIUM NITRATE. II. SALTING OUT BY MIXTURES OF TWO SALTING OUT AGENTS. Tikhomirov, V.; Ionov, V. P. Radiokhimiya, 9: 427-31(1967). (In Russian).

The additivity of their effects was established by the method of isonormal series of mixtures of salting out agents. The cross section parameters of each of the salting out agents in the mixture is equal to the parameters of the pure salting out agents. The experimental verification led to the assumption that the formation of the acid complex of the salting out agent is completed at anion concentrations of the salting out agent close to 2 N. The solvate number of the thorium nitrate in the extraction process with TBP in the presence of calcium nitrate was investigated at calcium nitrate concentrations from 0.5 to 2.0 M. It was established that under these conditions the solvate number maintains a constant value. (tr-auth)

10330 SALTING OUT DURING EXTRACTION OF THORIUM NITRATE. III. PRECALCULATION OF THE EFFECTS OF THE SALTING OUT. Tikhomirov, V. I.; Ionov, V. P. Radiokhimiya, 9: 431-5(1967). (In Russian).

The possibility of the precalculation of the distribution coefficients of different elements during extraction from mixed salt systems was demonstrated. The possibility of calculating the salting out isotherm for any salting out agent in the extraction system, containing different elements to be extracted and different extractants under conditions for the experimental determination of this isotherm for one of the salting out agents was also found. (tr-auth)

10331 EXTRACTION OF CERIUM(III) WITH ETHYLENEBIS-DIOCTYLPHOSPHINE OXIDE. Laskorin, B. N.; Smirnov, V. F.; Gorlov, F. E.; Zefirov, A. P. Radiokhimiya, 9: 435-8(1967). (In Russian).

The extraction of cerium(III) with ethylenebisdioctylphosphine oxide (EBOPO) from nitrate and nitrate–phosphate solutions was studied. The cerium concentration in the aqueous and organic solutions was determined using ^{144}Ce tracer. The distribution coefficient of cerium was found to change as the reciprocal of the square of $[H^+]$ and as the square of the concentration of the extractant in the organic phase. The equation for the reaction of extraction of cerium can be written as follows: $Ce^{3+} + 3NO_3^- + 2Y \rightleftharpoons Ce(NO_3)_3 \cdot 2Y$, where Y is a molecule of EBOPO. This reaction describes the extraction of any rare earth element under similar conditions. In the extracted compound, one molecule of extractant is linked by two (P = O) groups to the metal, forming a chelate ring; the other molecule of extractant is linked by only one bond, thus bringing the coordination number of the rare earth metal to six. (ATD)

10332 SEPARATION OF RARE EARTH ELEMENTS OF THE YTTRIUM SUBGROUP BY ELECTROLYSIS WITH MERCURY CATHODE. Shvedov, V. P.; Antonov, P. G. Radiokhimiya, 9: 478-3(1967). (In Russian).

The distribution coefficients for the following binary mixtures of the lanthanides were found to be Gd–Tb = 6 to 8; Gd–Ho = 10 to 40; Tb–Dy = 5 to 10; Tb–Ho = 10 to 30; Tb–Er = 20 to 40; Tb–Tm = 30 to 60. The quantitative separation of Gd and Tb from Lu and Y was established. The distribution coefficients were stable during changes within wide limits of the concentration ratio of rare earth elements in the electrolyte and increased somewhat with increase of the current density and electrolysis time. (tr-auth)

10333 POSSIBILITY OF SEPARATING MICROQUANTITIES OF ^7Be FROM Li. Rudenko, N. P.; Zhukovskaya, A. S. Radiokhimiya, 9: 483-9(1967). (In Russian).

The possibility of separating microquantities of ^7Be from large amounts of lithium by precipitation of lithium sulfate with nonaqueous solvents was investigated. The distribution of beryllium between the liquid and the solid phase ($Li_2SO_4 \cdot H_2O$) was determined both when lithium sulfate precipitate was introduced into the solution and when it was formed directly. $Li_2SO_4 \cdot H_2O$ was precipitated from a hot saturated solution by adding ethanol, acetone, or dioxane, in order to determine the influence of the nature of the precipitant on the distribution of ^7Be. The effects of foreign impurities on the distribution were also determined. The results were used to work out a method for separating microquantities of beryllium from gram amounts of lithium. (auth)

10334 SALTING OUT DURING EXTRACTION OF THORIUM NITRATE. I. SALTING OUT ISOTHERM (25°C) DURING EXTRACTION OF THORIUM NITRATE WITH SOLUTIONS OF TRI-n-BUTYL PHOSPHATE AND TRI-n-OCTYLAMINE. Tikhomirov, V. I.; Ionov, V. P. Radiokhimiya, 9: 419-27(1967). (In Russian).

It was established that during the extraction of mineral salts the regularities of the salting out effects of the electrolyte are near in character to those observed in classical cases of the salting out of nonelectrolytes. The totality of the effect of salting out indicates a similar mechanism or close to that. The most simple and logical explanation of the anomalies observed in this phenomenon is that the extraction complex formation occurs in the aqueous phase. The effects of the salting out led to a change of the interphase distribution of the extractant and extracting complex. The linear dependence of the cross section parameters of the salting out on the radius of the salting out cation indicated a determining role in the salting out process of near hydration of the salting out cation. (tr-auth)

10335 CHROMATOGRAPHIC SEPARATION OF SOME LANTHANIDES AND ACTINIDES ON ZIRCONIUM PHOSPHATE. Trofimov, A. M.; Kovalev, G. N.; Pitalev, V. G. Radiokhimiya, 9: 409-12(1967). (In Russian).

The chromatographic separation of the radioisotopes ^{140}La, ^{144}Ce, ^{147}Pm, $^{152,154}Eu$, ^{239}Pu, ^{241}Am, and ^{242}Cm on zirconium phosphate was studied by measuring the beta and alpha activities. It was found that lanthanides and actinides can be separated on zirconium phosphate by means of a concentrated weakly acidic solution of $LiNO_3$, which is usually employed in anion exchange chromatography. Organic eluent solutions used in the chromatography of actinides and lanthanides on ion exchange resins were not suitable for zirconium phosphate. The separation of the elements studied was favored by the fact that the stability of nitrate complexes in the series Ce, Am, Cm, Pm, and Eu decreases, whereas the stability of phosphate complexes increases. (ATD)

10336 ANION EXCHANGE STUDY OF SOME ELEMENTS STRONGLY ADSORBED FROM SULPHURIC–HYDROFLUORIC ACID MIXTURES. Danielsson, L. (Swedish Inst. for Metal Research, Stockholm). Ark. Kem., 27: 459-66(1967).

Adsorption by Dowex 1 × 8 from solutions of H_2SO_4–HF, Mo(VI), Nb(V), Sb(V), Sn(IV), Ta(V), Ti(IV), V(V), W(VI), and Zr(IV) was studied at 3 different concentrations of H_2SO_4: 0.1, 1.0, and 5.0N containing varying concentrations of HF, 0.1, 0.3, 1.0, and 5.0N. Solutions of H_2SO_4–HF were found to be less suitable for the total elution of the adsorbed elements than corresponding solutions of HNO_3–HF. (auth) (Sweden)

10337 EFFECT OF TEMPERATURE ON THE HEDTA- AND EDTA-ELUTION POSITIONS OF YTTRIUM IN THE RARE-EARTH SEQUENCE. Morton, J. R.; James, D. B. (Michigan Chemical Corp., St. Louis). J. Inorg. Nucl. Chem., 29: 2997-3001(Dec. 1967).

Varying the elution temperature in the ion exchange separation of an yttrium–lanthanide mixture shifted the elution position of yttrium. With HEDTA as the eluant the position of yttrium at room temperature was slightly ahead of neodymium; at 90 to 95°C it was between terbium and gadolinium; and at 45 to 50°C it was in the vacant promethium position. A practical scheme for the purification of yttrium was devised using this shift of position. With EDTA the elution position of yttrium was always between terbium and dysprosium; but increasing temperature decreased the dysprosium–yttrium separation factor, possibly negating any increased separation efficiency resulting from the decreased theoretical plate height. (auth) (UK)

10338 RADIOCHEMICAL SEPARATION OF ZINC BY AMALGAM EXCHANGE. Qureshi, I. H.; Nagi, F. I. (Atomic Energy Centre, Lahore). J. Inorg. Nucl. Chem., 29: 2879-84 (Dec. 1967).

An amalgam exchange technique was used for the rapid radiochemical separation of zinc. A number of variables that affect the exchange were studied and optimized. With an optimized procedure zinc yields of 95 per cent were obtained with less than 0.1 per cent contamination from most typical elements. Mineral acids and alkalies below 1 N concentration did not affect the exchange. At 25°C the over-all separation required about 12 min, whereas at 35°C it could be completed in about 6 min. The kinetic studies indicated that the exchange is a first order reaction. The rate constants and the apparent activation energy of the amalgam exchange reaction were determined. (auth) (UK)

10339 RADIOCHEMICAL SEPARATION TECHNIQUE FOR PALLADIUM. Boswell, G. G. J.; McGee, T. (Univ. of Salford, Eng.). Analyst, 92: 769-72(Dec. 1967).

The solvent extraction of the palladium complex with 2,4-pentanedione with benzene was studied and found to be a rapid, efficient, and selective method for the radiochemical separation of palladium from fission and spallation products. The yield of the palladium was 90 per cent in the absence of chloride ions. Radiochemical purity was found to be good. (auth) (UK)

10340 ZEOLITE STUDIES. I. SYNTHESIS OF SOME ALKALINE EARTH ZEOLITES. Hawkins, Daniel B. (Atomic Energy Commission, Idaho Falls, Idaho). Mater. Res. Bull., 2: 951-8(Oct. 1967).

Zeolites (hydrated alkali or alkaline earth aluminosilicates) possessing ion-exchange properties selective for Sr were synthesized. The zeolites were synthesized with a given ion in place, so that the structure conformed to the spatial needs of this ion. When the ion was then removed by ion exchange, the zeolite was expected to retain a "frozen-in" structural preference for the original ion; hence, should show ion-exchange selectivity for this ion. Zeolites were chosen for study because their structure should be sufficiently rigid to maintain the original configuration and not change with a change in counter ion. In addition, the high-silica zeolites are chemically resistant over a wide pH range and are stable in high radiation fields. Such properties make zeolites useful in the treatment of radioactive wastes. Strontium-selective zeolites should be useful in radioactive-waste treatment and in analytical chemistry. Methods are described whereby alkaline earth varieties of the high-silica zeolites mordenite, clinoptilolite, ferrierite, and yugawaralite were synthesized hydrothermally. A Ba clinoptilolite-like phase was synthesized reproducibly, apparently for the first time. The conditions favoring the formation of high-silica zeolites are low alkalinity and the use of reactants which produce a high-silica activity. Seeding was important for the synthesis of clinoptilolite. (BBB)

10341 CATION-EXCHANGE BEHAVIOUR OF SEVERAL ELEMENTS IN HYDROFLUORIC ACID–ORGANIC SOLVENT MEDIA. Korkisch, J.; Huber, A. (Univ., Vienna). Talanta, 15: 119-27(Jan. 1968).

The cation-exchange characteristics of 15 elements (including U, Zr, Nb, Ta, Pa) with the strongly acidic cation-exchange resin Dowex 50 × 8 were investigated in media containing varying concentrations of organic solvents and aqueous hydrofluoric acid. Determination of the distribution coefficients was carried out in 0.15 to 1.2 M hydrofluoric acid solutions containing 0 to 90% of the organic solvents methanol, ethanol, n-propanol, isopropanol, methylglycol, acetone, tetrahydrofuran, and acetic acid. Based on these distribution data the possibilities of separations of the various elements are indicated and discussed. (auth) (UK)

10342 THE N.F.S. DESIGN FOR A Np EXTRACTION INSTALLATION. Com. Naz. Energ. Nucl., Notiz., 13: 72-3 (Oct. 1967). (In Italian).

The results of a study requested by the N. Y. State Atomic and Space Development Authority on the N.F.S. installation for the processing of irradiated fuel elements for the recovery of Np are briefly summarized. The construction costs are indicated and the production costs for Np are estimated. The cost for the production of other elements in the case of construction of other extraction units are also estimated. (J.S.R.)

10343 NEW PLANTS FOR FAST REACTOR FUEL ELEMENTS IN FRANCE. Com. Naz. Energ. Nucl., Notiz., 13: 53-61(Oct. 1967). (In Italian).

The radiometallurgy Laboratory at Fontenay aux Roses and the AT-1 installation at The Hague are described. The construction and some of the individual hot cells are discussed. The AT-1 installation is for the processing of irradiated fuel elements from the breeder reactor of the power plant at the Hague. (J.S.R.)

10344 URANIUM RESERVES AND PRODUCTION IN THE WORLD. Com. Naz. Energ. Nucl., Notiz., 13: 49-52(Oct. 1967). (In Italian).

The production and sales by the principal uranium producers at the beginning of 1967 are outlined. The countries considered are Canada, the United States, South Africa, Australia, France, India, Portugal, and Spain. Price predictions are made. (J.S.R.)

10345 SOME ASPECTS OF THE AQUEOUS SOLUTION CHEMISTRY OF FISSION-PRODUCT ZIRCONIUM AND NIOBIUM IN NITRIC ACID. El-Guebeily, M. A.; Souka, N. (UAR Atomic Energy Establishment, Inshas). J. Chem. U.A.R., 8: 259-68 (1965).

The chemistry of Zr and Nb in extremely dilute solutions in nitric acid was investigated using ion–exchange resins. Cation exchange investigations in HNO_3 showed differences between ^{95}Zr and ^{95}Nb, both in rate of absorption and in equilibrium uptake for a range of acidities varying between 0.01 and 3M. In spite of the fact that Zr and Nb manifest great chemical similarities, their ionic species in HNO_3 and particularly their elution as function of pH may be different. The effect of ionic size of the Zr and Nb species on the internal diffusion of ions was found to be the rate-determining step in ion-exchange experiments. With the same ionic charge, the Nb and Zr complexes would have different sizes. Variation of the internal diffusion coefficient with concentration of HNO_3 for both ^{95}Zr and ^{95}Nb is shown. Lower values of internal diffusion coefficients of ^{95}Nb compared to those of ^{95}Zr for the same acidities (between 0.1 and 3M HNO_3) were found. At high acid concentrations, 5M and above, where simple complexes (i.e. not polymers) prevail, the 2 radioelements have practically the same behavior. They have the same internal diffusion coefficient in this acidity range. The low equilibrium uptake of both ^{95}Zr and ^{95}Nb at high HNO_3 concentrations could not be attributed to a change in the capacity of the resin. It may in part be due to the presence of anionic Zr and Nb species such as $(Zr(OH)_3(NO_3)_4)^{2-}$. (BBB)

10346 COPRECIPITATION OF RADIOACTIVE ISOTOPES WITH ISOMORPHOUS AND NONISOMORPHOUS CARRIERS FROM

FUSED SALTS. Klokman, V. R. Radiokhimiya, 9: 546-68 (1967). (In Russian).

To permit comparison of the results obtained in salt systems with those obtained in systems of solids in saturated aqueous solutions, the main conclusions obtained in the study of isomorphous and nonisomorphous coprecipitation in the crystallization of a solid phase from a saturated aqueous solution are presented. It is pointed out that the distribution of a microcomponent between liquid and solid phases is not yet completely known, that there is no general theory permitting calculation of the crystallization coefficient of a microcomponent in a given system starting from the physicochemical properties of the components alone, nor is there a single criterion for distinguishing true cocrystallization from the formation of anomalous mixed crystals, and that the formation of heterogeneous mixed crystals has not been studied in detail. These parameters of the distribution process are now being investigated for aqueous solutions. Studies of distribution in nonaqueous systems, in melts in particular, and of coprecipitation of trace elements from a solid phase crystallizing from a melt are traced. The investigations revealed a number of regularities, which indicate that the behavior of microcomponents in melts is very analogous to that in solutions and that the behavior of microcompounds distributed in fused salts at high temperatures has specific features. The information indicates the possibility of regulating coprecipitation in melts, that is, of producing solid or liquid phases preferentially enriched with a microcomponent by selection of the appropriate solvents, macrocomponents, temperature, gaseous medium and fluxes. (118 references). (JPRS)

10347 CONCURRENT EQUILIBRIA IN RADIOCHEMICAL SORPTION SYSTEMS WITH PARTICIPATION OF OXYHYDRATE COLLECTORS. Egorov, Yu. V.; Khrustalev, B. N. Radiokhimiya, 9: 569-88(1967). (In Russian).

Literature on concurrent interactions in sorption systems with the participation of oxyhydrate collectors and cationic microcomponents is surveyed. A systematization of the experimental data on the basis of a chemisorption exchange model and the law of mass action is proposed. (JPRS)

10348 THERMAL DIFFUSION IN A LOADED SPHERE–SMOOTH SPHERE MIXTURE: A MODEL FOR ^{4}He–HT AND ^{3}He–HD. Sandler, Stanley I.; Mason, E. A. (Univ. of Maryland, College Park). J. Chem. Phys., 47: 4653-8(Dec. 1, 1967).

The kinetic theory of a mixture of loaded spheres and smooth spheres of equal mass was developed as a model for thermal diffusion in the systems ^{3}He–HD, ^{4}He–HT, and ^{4}He–D_2. The inelastic effects in the loaded-sphere collisions were sufficient to explain the experimental "anomalies" observed in thermal diffusion involving the asymmetric hydrogen isotopes. The effects of spin polarization, though not dominant, were not negligible. (auth)

10349 ON THE ION-EXCHANGE BEHAVIOR OF FISSION-PRODUCT ZIRCONIUM AND NIOBIUM IN OXALIC ACID. El-Guebeily, M. A.; Souka, N. (UAR Atomic Energy Establishment, Inshas). J. Chem. U.A.R., 8: 275-81(1965).

The chemistry of Zr and Nb in oxalic acid solutions was studied using an ion-exchange resin. A highly basic anion exchanger (Merck Ion Exchanger III) was used. In contradistinction to the differences manifested in cation exchange behavior of ^{95}Zr and ^{95}Nb in HNO_3 solutions, these two elements manifested identical anion-exchange behavior in oxalic acid solutions. These results together with the absence of radiocolloids and of positive ionic species were expected on the basis of the strong complexing action of the oxalate ions in extremely large excess with respect to the trace amounts of these two radioelements. Negative complexes would therefore be predominant under such conditions, such as $[Zr(C_2O_4)_X]^{(X-4)-}$ and $[Nb(C_2O_4)]^{(Y-5)-}$. In such a strong complexing medium differences in behavior between Nb and Zr due to hot-atom properties were not anticipated. Even if the recoil energy of the daughter nuclides formed in the decay of ^{95}Zr would be greater than the chemical bonds in the complex ions and thus lead to the rupture of the latter, the liberated ^{95}Nb atoms would be in the highly complexing oxalic acid medium and tend to form complexes similar to those indicated above. The lower value of the equilibrium uptake of ^{95}Zr and ^{95}Zr–Nb at 83°C could not be interpreted as a decrease in the capacity of the resin since the studies were carried out with extremely small concentration of the radioelements (10^{-10}M) and experiments showed that the hydroxyl capacity of the resin remained practically the same after heating it in distilled water at 83°C. The observed diminution in equilibrium uptake was due partly to the formation of less absorbable species and partly due to some desorption at high temperatures involving molecules that might have been taken up by physical adsorption in parallel with the main anion exchange process. The presence of a slight minimum was seen in the equilibrium uptake at an oxalic acid concentration of 1%. This minimum was noted especially at 83°C. It did not seem to be due to steric conditions. The rate of uptake in 1% oxalic acid was the same as at 0.01 and 4% concentrations. Equilibrium took place very rapidly and the internal diffusion coefficients could not be determined. (BBB)

10350 POLYMERIZATION OF Mo(VI) IN ACID SOLUTIONS. Vorob'ev, S. P.; Davydov, I. P.; Shilin, I. V. Zh. Neorg. Khim., 12: 2665-76(Oct. 1967). (In Russian).

The polymerization of Mo(VI) in hydrochloric and nitric acid solutions at $\mu = 1$ was studied by spectrophotometric and extraction methods. It was found that the degree of polymerization and the number of Mo atoms in the polymer increased with a decrease of $[H^+]$. In the Mo(VI) concentration interval from 2.5×10^{-3} to 1.0×10^{-1} mole/l in hydrochloric acid solutions, the polymer number step by step increased with a decrease in the H^+ concentration and at $[H^+] = 0.25$ it was equal to 6. It was established that the polymerization of Mo(VI) proceeds with the formation of the polycation type $[(MoO_2)\ (MoO_3)_{n-1}]^{2+}$. The polymerization constants ($\beta_{1'}$) of Mo(VI) in hydrochloric and nitric acid solutions were calculated. For 1.0 mole solutions $\beta_{1'} = 520$ and $\beta_{2'} = 9.06 \times 10^5$ in hydrochloric acid solution and $\beta_{1'} = 95$, $\beta_{2'} = 1 \times 10^5$, and $\beta_{3'} = 1.23 \times 10^8$ in nitric acid solution. It was found that the extraction of Mo(VI) from nitric and hydrochloric solutions with TBP proceeded by the reaction MoO_2^{2+} aq + $1A^-$ aq + $2TBP_{org}$ $\rightleftharpoons [MoO_2A_2.2TBP]_{org}$. (tr-auth)

10351 PROCESS FOR THE RECOVERY OF SUBSTANCES FROM DILUTE SOLUTIONS. Hultgren, Valdemar (to Aktiebolaget Atomenergi). British Patent 1,097,137. Dec. 29, 1967. Priority date Aug. 13, 1964, Sweden.

A process for separating a substance from solution in an organic solvent is described for particular application to separation of Pu, Mo, Np, Th, Tc, and U, particularly ^{235}U and ^{233}U from solution. The solution is passed through a column of fine-grained material on which an aqueous solution is adsorbed. The organic solvent and aqueous solution are sufficiently insoluble in each other to form separate phases. The aqueous solution contains a compound that will react with the substance to be separated to form a second compound, which is sufficiently insoluble in the organic solvent to be retained in the column. The second compound is then eluted from the column by a suitable solvent. The fine-grained absorption material may be either silica gel, diatomaceous earth, or cellulose. The organic solvent may be an aliphatic, alicyclic, or aromatic, primary, secondary, or tertiary amine having from 10 to 50 C atoms. (B.L.M.)

10352 PROCESS FOR THE PURIFICATION OF TERTIARY AMINES. Bathellier, Andre; Perez, Jean-Jacques (to Commissariat a l'Energie Atomique). British Patent 1,096,707. Dec. 29, 1967. Priority date Aug. 17, 1964, France.

A method is described for the purification of tertiary amines by contacting the tertiary amine in solution or in the liquid phase with an activated natural earth and then separating the tertiary amine from the natural earth. In order to effect the desired degree of purification, the process is carried out at an elevated temperature of 40 to 50°C with contact times varying from 5 to 50 min. The amine may be contacted with activated C at the same time as with the activated earth. The process is especially applicable to the purification of trilaurylamine and tricaprylamine. (B.L.M.)

10353 PROCESS OF SEPARATION OF URANIUM AND THORIUM STARTING FROM A SOLUTION CONTAINING THESE TWO ELEMENTS. Huet, Henri; Lorrain, Christian; Mahut, Pene; Mariette, Rene; Vertes, Paul (to Commissariat a l'Energie Atomique). British Patent 1,095,761. Dec. 20, 1967. Priority date Feb. 14, 1964, France.

A method for the separation of U and Th from each other starting with an aqueous feed of their nitrates consists of contacting the aqueous feed with a solution of TBP in an organic medium with the respective volumes of the feed extractant being such that the concentration of U in the organic phase is close to theoretical saturation. The organic phase is scrubbed with an aqueous solution of HNO_3 or of uranyl nitrate acidified with HNO_3 and containing complexing ions for Th in an amount sufficiently small to keep the organic phase saturated with U. The U is recovered by scrubbing the organic phase. The complexing ions for Th contained in the aqueous scrubbing solution are selected from phosphates, sulfates, fluorides, oxalates, and mixtures of these. (B.L.M.)

10354 METHOD FOR SEPARATING MEMBERS OF ACTINIDE AND LANTHANIDE GROUPS. (to United States Atomic Energy Commission). British Patent 1,098,350. Jan. 10, 1968. Priority date Sept. 18, 1964, United States.

A solvent extraction process for the separation of lanthanide and actinide elements is given. Since quaternary ammonium

compounds in the presence of thiocyanate preferentially extract actinides from lanthanides, an acidic solution of the metals is contacted with a mixture, such as tricaprylmethyl ammonium thiocyanide–xylene, and the resulting metal-containing organic solution separated from the aqueous phase. The process has many advantages including the high single stage separation factors (the separation factors for californium/lanthanum is 9800 in 0.2 N sulfuric acid). The method can also be applied to the separation of actinides from each other and the separation of lanthanides from each other. (D.H.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 10385, 10511, and 11754.

10355 (MIT–952–4, pp 300–38) NUCLEAR GEOCHEMISTRY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Studies were made of the diffusion of radon through porous materials, particularly in multilayered assemblies, in both the plane and the spherical geometries. Attention was given to the selective removal of radon daughter products from underground air and to general principles of mine ventilation. (auth)

10356 (ORO–490–12) RADIOACTIVITY TRANSPORT IN WATER: MATHEMATICAL MODEL FOR THE TRANSPORT OF RADIONUCLIDES. Shih, Chia Shun; Gloyna, Earnest F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). June 1, 1967. Contract AT(11-1)-490. 179p. (EHE–04–6702; CRWR–18). Dep. CFSTI.

The purpose of this study was to develop a mathematical model which describes the transport of radionuclides injected instantaneously in a stream. Particular emphasis was directed to the influence of sediments on transport. Instantaneous release of dye and continuous release of ^{85}Sr, respectively, were used to measure the dispersion and mass transfer coefficients. Aquaria and model river experiments were undertaken to determine various parameters which define the mechanism of sorption and desorption of radionuclides by sediments. Instantaneous injection of ^{85}Sr into the model river provided data for establishing the relationship between the analytical solution and a proposed mathematical model. FORTRAN programs were designed for the analyses of gamma spectra, dispersion coefficients and transport equations. Some of the important factors affecting the transport of ^{85}Sr in the model river were studied. The mass transfer coefficient was found to increase with increased velocity. High uptake of ^{85}Sr by sediments may be provided by increased temperature and the presence of an organic pollutant. An exponential relationship was established between the Sherwood's number and the Reynold's number for the model river. (auth)

10357 (RISO–154) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1966. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1967. 100p. Dep.

The measurement of fallout radioactivity in Denmark in 1966 is reported. ^{90}Sr was determined in samples from all over the country of precipitation, soil, ground water, seawater, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Furthermore ^{90}Sr was determined in local samples of air, rainwater, grass, sea plants, animal bone, fish, meat, and human milk. ^{137}Cs was determined in milk, grain products, potatoes, vegetables, fruit, total diet, pork, beef, and human milk samples, and ^{137}Cs was measured by wholebody counting in persons from a control group at Risö. Estimates of the mean contents of radiostrontium and radiocaesium in the human diet in Denmark in 1966 are given. Regular surveys of environmental samples from the Risoe area are included. (auth)

10358 (RISO–155) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1966. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 23p. Dep.

Measurements of fallout radioactivity in the Faroes in 1966 are presented. ^{90}Sr (and ^{137}Cs in most instances) was determined in regularly collected samples of precipitation, milk, potatoes, sheep, fish, and drinking water. In addition, analyses of spot samples of grass, soil, sea water, sea plants, birds, vegetables, bread, cheese, eggs, and human bone were carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1966 are given. (auth)

10359 (RISO–156) ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1966. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 21p. Dep.

Measurements of fallout radioactivity in Greenland in 1966 are reported. ^{90}Sr (and ^{137}Cs in most instances) was determined in samples of precipitation, soil, sea water, vegetation, animals, and drinking water. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1966 are given. (auth)

10360 (TEI–872) RECORDS OF WELLS AND TEST HOLES IN THE NEVADA TEST SITE AND VICINITY THROUGH DECEMBER 1966. Thordarson, William; Young, R. A.; Winograd, I. J. (Geological Survey, Washington, D. C.). Dec. 1967. 26p. Dep. CFSTI.

Hydrogeologic and construction data obtained from 119 test holes, wells, and emplacement holes at the Nevada Test Site and vicinity are tabulated. The availability of cuttings, cores, lithologic logs, geophysical logs, formation-water analyses, hydraulic test data, and detailed construction data for each hole, as well as references to published reports for selected holes, are noted. (auth)

10361 (TID–24209) HYDRAULIC TESTING TECHNIQUES OF DEEP DRILL HOLES AT PAHUTE MESA, NEVADA TEST SITE. Blankennagel, Richard K. (Geological Survey, Denver, Colo.). 1967. 50p.

The testing techniques used to obtain hydrologic data in deep holes drilled in volcanic rocks at Pahute Mesa, Nevada Test Site, are described. The testing program in each hole includes geophysical logging, pumping, and injecting and swabbing between straddle packers. Rock lithologies and qualitative data on hydrologic conditions in the borehole are obtained from electric, caliper, temperature, and fluid resistivity logs. Quantitative data on major water-yielding intervals in the borehole are obtained from radioactive tracer and spinner surveys. Pumping tests are made to measure the combined yield of the various aquifers. Injection and swabbing tests are made by adding known volumes of water to, or withdrawing known volumes of water from, straddle-packed intervals and observing the rate of decline or rise in water level resulting from this injection or withdrawal of water. The yield of tested intervals is stated as relative specific capacity, in units of gallons per minute per foot of drawdown. (auth)

10362 INVESTIGATION OF KINETICS OF LIBERATION OF ARGON ISOTOPES FROM URANINITES IN CONNECTION WITH THE PROBLEM OF ORIGIN OF ^{38}Ar. Shukolyukov, Yu. A.; Tolstikhin, I. N.; Ashkinadze, G. Sh. (Lab. of Precambrian Geology, Leningrad). Geochem. Int. (Engl. Transl.), 3: 738–51 (1966).

Argon in the 3 uraninites which were assayed was enriched in ^{38}Ar and ^{40}Ar relative to ^{36}Ar. Fractionation of the Ar isotopes occurred when the uraninites were heated. In some fractions enrichment in ^{38}Ar amounted to 1000 to 3500%. The curves of liberation of radiogenic Ar from the uraninites showed 4 peaks, at 300 ± 100°, 700 ± 150°, 1100 ± 100°, and 1400 ± 100°C. The activation energy of liberation of radiogenic ^{38}Ar from uraninites ranged from 35 to 300 kcal/mole, indicating that radiogenic Ar occurs within the crystal structure. There was no correlation between the contents of radiogenic ^{38}Ar and K. Available experimental data on the content of radiogenic isotopes in U minerals suggested the hypothesis that ^{38}Ar may form as a result of spontaneous fission of heavy nuclei. (BBB)

10363 APPLICATION OF DATA ON THE NATURAL RADIOACTIVITY OF ROCKS FOR CONSTRUCTING A TECTONIC SCHEME OF THE UKRAINIAN SHIELD. Gerasimov, Yu. G. (Inst. of Geophysics, Kiev). Geofiz. Astron. Inform. Byull., No. 9, 48–53(1966). (In Russian).

The high mobility of hexavalent uranium and the low mobility of tetravalent thorium give rise to their different behavior under supergenic conditions; uranium is leached from the rocks in the oxidation zone and is concentrated in the depressed areas with a reduction regime, thorium is mechanically transported to elastic rocks. The nature of the distribution is not essentially altered during subsequent metamorphosis of the rocks. The number of tectonic blocks in the Ukrainian shield can therefore, be traced by the nature of the radioactivity fields of the crystalline rocks. (auth)

10364 THE MOVEMENT OF COPPER, MOLYBDENUM, AND SELENIUM IN SOILS AS INDICATED BY RADIOACTIVE ISOTOPES. Jones, G. B.; Belling, G. B. (CSIRO, Adelaide). Australian J. Agr. Res., 18: 733–40(Sept. 1967).

Copper-64, ^{99}Mo, and ^{75}Se were applied to various soils to study their movement under the influence of various fertilizer treatments. With soils of moderate exchange capacity, ^{64}Cu remained near the surface following all fertilizer treatments and the equivalent of several years' rainfall. With light soils of low exchange capacity some penetration of ^{64}Cu occurred, especially following superphosphate and an aqueous extract of lucerne. With ^{99}Mo, in general, a high proportion was leached right through the soils, except in the case of the 2 laterite soils examined, where up to half of the ^{99}Mo was retained near the surface. Selenium-75 applied as sodium selenite was intermediate between the extremes illustrated by ^{64}Cu and ^{99}Mo, in that a high proportion was retained

by the calcareous soils but not necessarily at the surface. The lighter soils retained a much lower proportion of selenium. (BBB)

10365 NATURAL RADIOACTIVITY OF THE SCHIRMACHER PONDS. Eremin, N. N. Sov. Antarct. Exped. Inform. Bull., 5: No. 55, 18-19(1965).

The Ninth Soviet Antarctic Expedition made observations at Novolazarevskaya Station of the natural radioactivity of settling dusts and aerosols by the sedimentation method (with trays), as well as of precipitation (water, snow, and ice), soil and vegetation (mosses, lichens, and algae). The activity of settling dusts and aerosols was examined as a function of wind velocity and the amount of precipitation. Maximum activity was recorded in October (7.0×10^{-4} Ci/km^3/month) when maximum mean monthly wind speed and the maximum amount of precipitation were also recorded. There was a marked decrease in the β activity of precipitation from August to October (from 8.1×10^{-8} to 0.2×10^{-10} Ci/l), probably associated with atmospheric circulation and also dependent on the region of the earth from which a particular air mass arrived. The results of measurements of the β activity of water from the lakes in the Schirmacher Ponds and of land ice were all beyond the limits of accuracy of the measuring equipment, i.e., below 10^{-15} Ci/l, or below 10^{-15} Ci/kg. Substantial fluctuations of the β activity of soils were associated with the type of ground. All sandy soils had an activity of the order of 10^{-15} Ci/kg and less. Disintegrated rocks and soil had the highest activity. The activity of vegetation was of the same order of magnitude as that of the soil where it was collected. The activity of mosses and lichens in other parts of the world is one order of magnitude higher (10^{-7} Ci/kg) than in the Schirmacher Ponds. It was concluded that the natural radioactivity of the Schirmacher Ponds is substantially lower than in the rest of the world. (BBB)

10366 POSSIBILITY OF ABSOLUTE DATING OF ORGANIC SEDIMENTS BY THE IONIUM METHOD. Titayeva, N. A. (Univ. of Moscow). Geochem. Int. (Engl. Transl.), 3: 941-50(1966).

Data on Th, U, Ra, and ^{230}Th contents in unconsolidated sediments and associated ground waters (southwestern part of the Siberian shield) indicated concentration of U from the water by organic matter. Despite the low (0.2 to 0.3×10^{-6} g/l) concentration of U in the surface water concentration of U from the water by the organic matter of the mud and peat bogs occurred. Conspicuous enrichment of organic sediments with Ra could be observed only when Ra concentration in the water was high; this enrichment did not exceed the U-equilibrium concentration. The ^{230}Th enrichment of the orgainc sediments was even less pronounced, and Th enrichment was observed hardly at all. It might be expected that the greater part of ^{230}Th migrates by a mechanical process, so that the original ^{230}Th concentration in the sediment may correspond to its concentration in the mineral part of the sediment. On the basis of several assumptions a method is suggested for calculating the age of Quaternary alluvial deposits through the ^{230}Th/U ratio, taking into account the initial concentrations of these elements supplied mechanically. Theoretically possible variants which were suggested for the selection of initial concentrations require further examination. (BBB)

10367 RADIOGENIC ISOTOPES OF KRYPTON AND XENON IN URANINITES OF NORTH KARELIA. Shukolyukov, Yu. A.; Tolstikhin, I. N. (Lab. of Precambrian Geology, Leningrad). Geochem. Int. (Engl. Transl.), 3: 934-40(1966).

Spontaneous fission of ^{238}U is accompanied by the formation of radiogenic Xe and Kr in constant ratio. In general, radiogenic Xe and Kr will not be retained in highly active minerals. When there are varying losses of radiogenic Xe and Kr, it is theoretically possible to calculate the true age of U minerals if the Xe/U and Kr/U ratios in each are known. The He/U ratio may also be included in the calculation, where He is the He concentration due to α decay of ^{238}U alone and U is the U concentration found experimentally. To determine the possibilities of mineral age estimation by a Xe–Kr method, the concentration of radiogenic isotopes of Kr, Xe, and He, and also of U and Th, was assayed in 5 uraninites from North Karelia. It was concluded that variations in isotopic composition of Kr and Xe in these uraninites are due to differences in the contribution of neutron-induced fission of ^{235}U. The ages calculated for the uraninites on the basis of experimentally found values for the He, Kr, and Xe concentrations were considerably lower (2 to 200 times) than the ages found by the lead method, owing to the emigration of radiogenic gases. (BBB)

10368 RADIOACTIVE SUBSTANCES IN SEWAGE AND DRINKING WATER. Aurand, Karl (Bundesgesundheitsamt Institut fuer Wasser-, Boden-, und Lufthygiene, Berlin). Roengenpraxis, 19: 266-76(Oct. 1966). (In German).

The increases in amounts of various radioisotopes used in Germany from 1956 to 1963 are considered and compared with the amounts used in 9 of the major hospitals. The amounts of radioisotopes used in 1960 and 1965 are compared in terms of their maximal permissible concentrations in sewage volumes, theoretically and in practice. The average ratio between the sewage concentrations in 1965 and 1960 was 3.6. The pathways of diffusion of radioactive substances through various life cycles and from industrial and natural sources are outlined briefly. The over-all program for supervision, testing, and measurement of radioactivity of water is illustrated and described. Sampling instruments to measure radioactivity in flowing water and in sediments are described and their modes of operation are discussed. Results of measurements of radioactivity in sewage and cistern waters for the period from 1962 to 1965 are graphed. For the period 1959 to 1966 the ^{90}Sr specific activity of cistern waters and fallout in Schleswig-Holstein, Lower Saxony, and drinking water taken from the Weser is charted. The radioactivity in ground waters for the period 1962 to 1965 is illustrated. (BBB)

10369 CHROMATOGRAPHIC TRANSPORT THROUGH SOILS. II. COLUMN EXPERIMENTS WITH Sr AND Ca ISOTOPES. Frissel, M. J.; Poelstra, P. (EURATOM, Wageningen, Netherlands). Plant Soil, 27: 20-32(Aug. 1967).

Some chromatographic theories considered applicable to soils were used to calculate radioisotope distribution patterns in columns. The results of these calculations are compared with experimental distributions. In studies with ^{90}Sr, ^{85}Sr, and ^{45}Ca the exchange material used was mainly Dowex 50W–X8 completely saturated with Ca ions, and in a few experiments Ca-illite was used (illite 80%, montmorillonite 5 to 10%, kaolinite 5%, quartz 5 to 10%). For the transport experiments tubes 3.5 cm in diameter and 40 cm long were filled with resin or a resin-sand mixture. A 2-cm layer of the same material was placed on top and labeled with ^{90}Sr, ^{85}Sr, or ^{45}Ca. The rate of transport of the Ca and Sr ions in resin-sand mixtures was measured at water fluxes ranging from 75 to 59,440 cm/cm^3/yr, the distribution coefficient for these ions varying from 8 to 408. The rates measured agreed well with the calculated values. The dispersion pattern that developed during chromatographic transport was compared with some calculated dispersion patterns and the calculations were based on different theoretical approaches. In this way some assumptions concerning the general or partly general validity of these theories could be verified. There was good agreement between experiments on clay-sand and on resin-sand mixtures. (BBB)

10370 INVESTIGATIONS ON ^{90}Sr WASH-OUT IN SOILS. Reissig, Herbert (Technische Univ., Dresden). Chem. Erde, 25: 204-29(1966). (In German).

The sorption, distribution, and migration of ^{90}Sr are discussed on the basis of literature data. A mathematical model proposed by Thornthwaite et al. was applied to the results of lysimeter studies on ^{90}Sr leaching by precipitation (carried out from 1959 to 1965). The migration of ^{90}Sr in soils with average to high cation exchange capacity shows a close agreement with the mathematical model. The deviations occurring in soils with low cation exchange capacity can probably be traced back to the relatively fast ground water flow through these soils so that the interaction of ^{90}Sr ions with the soil sorption complex was sharply limited. A negative relation exists between the cation exchange capacity of the soil and the ^{90}Sr migration rate. Some vertical profiles were reported and discussed on the distribution of ^{90}Sr in a contaminated field. Fallout of ^{90}Sr in cultivated meadows and waste lands was also discussed. Both the lysimeter studies and investigations on naturally layered soils show that the ^{90}Sr migration rate is below 1 cm/700 mm precipitation in most soils. (tr-auth)

10371 ^{26}Al AND ^{10}Be IN GREENLAND ICE. McCorkell, R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Fireman, E. L.; Langway, C. C. Jr. Science, 158: 1690-2(Dec. 29, 1967).

Activities of ^{10}Be and ^{26}Al dissolved in 200-year-old Greenland ice were found to be 18.4 (+8.4, −4.8) $\times 10^{-6}$ and $3.2 \pm 0.9 \times 10^{-7}$ disintegration per minute per liter, respectively. From these values and the precipitation rate (30 milliliters of water per square centimeter per year), the production rates of these isotopes are calculated to be 3.6 (+1.6, −0.9) $\times 10^{-2}$ and $1.7 \pm 0.5 \times 10^{-4}$ atom per second per square centimeter. These rates agree with the rates calculated for the production of these isotopes by cosmic rays in the atmosphere. Probably all the ^{26}Al in the ice is accounted for by such atmospheric production; however, an upper limit for the influx of cosmic dust bearing ^{26}Al is calculated at 3.2×10^5 tons per year for Earth. Only upper limits could be found for ^{26}Al and ^{10}Be in the undissolved particulate matter in the ice; their addition to the activities in the dissolved material leaves the conclusions unchanged. (auth)

10372 RADIOISOTOPE MIGRATION IN SOIL. Baetsle, L.; Maes, W. (SCK–CEN, Brussels). Pedologie, 14: 205-27 (1964). (In Flemish). (BLG–396).

The migration of radionuclides in soils may be described by two easily determinable parameters: the distribution coefficient and the dispersion coefficient. Studies of ionic equilibria in soils have led to the formulation of the distribution coefficient (Kd: ml/g) which is directly related to the velocity of the migration of radio elements in soils. The degree of dispersion of migrating radionuclides in porous media can be expressed quantitatively by the dispersion coefficient (D: cm^2/sec), which takes into account the physical characteristics of the medium and the phenomena due to molecular diffusion. Longitudinal as well as transversal dispersion is discussed. From the undertaken investigations it appears that in isotropic porous media and at low migration velocity a moving point source transforms into a spherical cloud and into an ellipsoid when velocity rises. Injections with radionuclides in nature have confirmed the above conceptions. (auth)

10373 CONCENTRATION OF RADIOACTIVE ISOTOPES IN ENVIRONMENTAL WATER MEASURED BY UNDERWATER GAMMA SPECTROMETRY. Riel, Gordon Kienzle. College Park, Md., University of Maryland, 1967. 206p.
Thesis.

Recently developed underwater gamma-ray (γ) spectrometers have been used to measure the concentrations of γ-emitting isotopes in extremely dilute solutions. For example, the sensitivity attained for detection of ^{137}Cs in the ocean was one pCi/l which corresponds to a concentration of about 10^{-14} g/l. The identification of specific isotopes is possible because the underwater spectrometers are capable of measuring the γ-ray energies of the sources. Gamma radiation background spectra have been measured in the Atlantic and Pacific Oceans and in Tridelphia Reservoir, Maryland. Spectra were also determined in the following bodies of water, which are used to cool nuclear reactors: The Columbia, Savannah, Potomac, Susquehanna, and Hudson Rivers, Sherman Pond, Massachusetts, and the pool water of the University of Maryland Reactor. The spectrometer's counting efficiency has been measured for 17 radioactive isotopes dissolved in water as standards. The background and efficiency data have been used to predict the sensitivity for detection of isotopes which may be added to water. These background spectra have also been analyzed to find the concentration of isotopes already present. Thus, concentrations of naturally occurring isotope ^{40}K and the fallout isotope ^{95}Zr in the ocean have been determined from 1960 to 1966. Also excess activity (greater than ^{40}K and ^{95}Zr) has been observed in the ocean with energies from 0.44 to 0.70 MeV and has been attributed to a variety of natural and artificial isotopes. The same isotopes have been observed in the Tridelphia Reservoir. Spectra measured in the rivers and the pond serving reactors were reduced by a computer program to find the concentration of the three naturally occurring radioactive isotopes (^{40}K, ^{226}Ra, and ^{232}Th), and seven reactor-produced isotopes (^{24}Na, ^{51}Cr, ^{56}Mn, ^{60}Co, ^{65}Zn, ^{131}I, and ^{137}Cs). The natural isotopes were found at all sites. The artificial radioactive isotopes (concentration in pCi/l) found are: The Columbia River, ^{51}Cr (3,370) and ^{65}Zn (20); the Potomac River, ^{60}Co (2); the Hudson River, ^{137}I (1.7), ^{24}Na (1.2) and ^{56}Mn (7). For comparison, 800 pCi of ^{24}Na per liter were found in the pool water of the University of Maryland Reactor. The above rivers serve the Hanford, Ft. Belvoir, and Indian Point reactors, respectively. The Columbia River contains considerable artificial radioactivity downstream from Hanford. At the other two sites, only traces of artificial radioactivity very near the reactor and at concentrations well below the natural background were found. (Disser. Abstr.)

Meteorology

Refer also to abstracts 10357–10359, 10371, 10533, and 12159.

10374 (FOA-4-4495-28) FALLOUT GAMMA-EMITTING RADIONUCLIDES IN AIR, PRECIPITATION, AND THE HUMAN BODY UP TO SPRING 1967. Lindblom, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Dec. 1967. 26p. Dep.

Measurements of some radionuclides, especially ^{137}Ca in stratospheric air, ground level air, precipitation, and the human body are discussed. First during 1967, four years after the cessation of large scale atmospheric testing in late 1962, the supply of stratospheric ^{137}Cs to the ground will be balanced by decay of the activity already deposited. Average ^{137}Cs body burdens have been halved in every 1.5 years since maximum values occurred during 1964. Internal and external gamma-doses were calculated. Measured ratios between some other long-lived radionuclides and ^{137}Cs are discussed. Some ^{7}Be concentration values are reported. (auth)

10375 (IDO-12059) METEOROLOGY FOR THE LOSS OF FLUID TEST REACTOR. 2nd Progress Report, January 1966–January 1967. Dickson, C. R.; Start, G. E.; Markee, E. H. Jr.; Richter, A. P.; Kearns, J. (Environmental Science Services Administration, Idaho Falls, Idaho. Air Resources Field Research Office). July 1967. 55p. Dep. CFSTI.

The revaluation, operations, and special studies for the meteorology for the Loss of Fluid Test (LOFT) Reactor are reported. The LOFT meteorology revaluation consists of a construction of the "most likely" hourly conditions of wind and stability for the four seasons, the presentations of trajectories of effluents carried by the "most likely" patterns and illustrations of trajectories from extreme observed conditions, the calculations of the "most probable" seasonal patterns of accumulated relative dose factors, (χ/Q), over the upper Snake River Plain, and the computation of maximum (χ/Q) values for long-period releases under the extreme conditions observed at TAN. Operations include an evaluation of practice five-day forecasts of "GO" versus "NO-GO" conditions at LOFT and the results of an attempt to discover objective forecasting techniques for southwest winds over the entire NRTS area. Special studies comprises smoke-plume photography techniques under nighttime inversion conditions, plume depletion, the prediction of nil ductility temperatures on the EBR II containment vessel, and tetroon trajectories over the LOFT area. (auth)

10376 URANIUM CONTENT OF ATMOSPHERIC AEROSOLS. Smirnov, L. E.; Kononova, L. N. Geochem. Int. (Engl. Transl.), 3: 909-12(1966).

A study of U content of the troposphere was done using aerosol samples taken by airborne filters. The samples were calcined at 400 to 500°C and dissolved in a mixture of hydrofluoric and nitric acids. It was shown that it is possible to apply the fluorometric method of U determination to samples of atmospheric aerosols taken at heights of between 2 and 10 km. It was established that the interference of quenching elements may be disregarded when analyzing atmospheric aerosols. U content was determined in the ash of the filter. Correction for U content in the ash of the filter was between 2 and 10%, and exceptionally reaching 15 to 20%. The total error of fluorometric determination of U in the atmospheric aerosol samples did not exceed 20%. The mean monthly U concentrations in 1959 is shown. The increased (28×10^{-10} g/m^3) U content at the beginning of 1959 was probably due to intensive nuclear weapon tests in 1958. Uranium concentration at the end of 1959 ($\sim 1 \times 10^{-10}$ g/m^3) was approaching the natural U concentration. (BBB)

10377 ADMIXTURES OF THE ATMOSPHERE. Lablans, W. N. Hemel Dampkring, 65: 42-54(1967). (In Dutch).

Admixtures in the troposphere of radioactive emanations, tropospheric aerosols, and light contaminants are described. The removal mechanisms of particles from the troposphere are outlined. The trace materials in the stratosphere are described. The transport of trace materials from the stratosphere to the troposphere is discussed. (J.S.R.)

10378 ^{87}Rb CONCENTRATION IN MARKET MILK. Murthy, G. K. (National Center Urban and Industrial Health, Cincinnati). J. Dairy Sci., 50: 818-19(June 1967).

The average ^{87}Rb concentration in milk varied from 14.2 to 84.8 pCi/kg of sample. Statistical analysis of the data showed that the ^{87}Rb concentration in milk from various cities was significantly different at $\alpha = 0.01$. Samples from cities in the southeast showed significant differences from one sampling period to another. In general, the ^{87}Rb concentration in milk from inland states was less than that of milk from cities of coastal states and those lying in the Missouri and Mississippi Valley. (Public Health Eng. Abstr.)

10379 CONTRIBUTION TO MICROANEMOLOGY AT ISPRA. Gandino, Claudio (EURATOM, Ispra, Italy). Geofis. Meteorol. (Genoa), 16: 13-17(Jan.-Apr. 1967). (In Italian).

The necessity for and problems associated with wind measurements at nuclear installations are discussed, with particular reference to anemometry. Wind parameters must be investigated in order to provide accurate data in the event of release of radioactivity. The location of various meteorological stations in relation to the Ispra-I reactor is described. These stations provide wind direction, velocity, turbulence, and other parameters. In addition, as in other nuclear centers, Ispra utilizes anemographs, horizontally distributed, for determining the direction of a radioactive cloud. For the forecast of the wind variations, climatological data are processed with an IBM-7090 computer. (BBB)

10380 ON THE INFLUENCE OF THE THIRD CHINESE NUCLEAR TEST. Oki, Iwashiro; Yoshida, Sachiko (Osaka Public Health Inst.). Osaka-Furitsu Koshueisei Kenkyusho Kenkyu Hokoku, No. 4, 58-60(Mar. 1967). (In Japanese).

Mainland China carried out its third nuclear test on May 9, 1966. In order to investigate its influence, measurements were made of the radioactivities in rainwater, airborne dusts, and high-level

radioactive particles. Although the activity in rainwater showed very high values compared with other nuclear tests, the radioactivity in airborne dusts was lower than in the second test. One feature of the nuclear test was a large contribution of high-level radioactive particles, shown by the measurement of rainwater and such particles. Another feature was, the time of arrival after test was the shortest, approximately one day. On the whole, the radioactivities detected were not such as to require any counter measures, and the influence also was gradually diminished. (NSA of Japan)

10381 BULLETIN OF THE ATMOSPHERIC RADIOACTIVITY, NO. 46, JULY-SEPTEMBER 1966. Taiki Hoshano Kansoku Seiseki, No. 46, 1-60(July-Sept. 1966).

Tables of the measurements of temporary standard samples of U_3O_8 at Japanese stations are given. Summaries of mean radioactivity and observed radioactivity in rain collected at a fixed time daily are included. The observed radioactivity in airborne dusts is tabulated. Radioactive measurements in sea water, rain water, and falling dust are recorded. (J.C.W.)

10382 DEPOSITION OF RADIOACTIVE FALLOUT OF 4TH COMMUNIST CHINESE NUCLEAR TEST CARRIED BY GUIDED MISSILE IN NIIGATA. Kosaka, Takao; Takizawa, Yukio (Niigata Univ., Japan). Niigata Igakkai Zasshi, 81: 75-9 (Feb. 1967). (In Japanese).

Communist China conducted its fourth nuclear test with a guided missile in October 1966. After the test, a survey was made on the deposition of fallout, including highly radioactive particles, precipitation, airborne, and falling dusts. The amount and specific activities of the particles were low, compared with the preceding third nuclear test. Microscopic examinations indicated that the particles were spherical in shape and brown in color with diameters ~20 μ, as compared to 10 μ for the third test. Radioactivity in the rainfall was high, and was detected for over one month. Radioactive dust content in the air was not particularly high at the time the highly radioactive particles fell. They were detected for one month. Deposition of radioactive dusts, although varied somewhat, followed the same tendency as that of radioactive rainfall. (NSA of Japan)

10383 FALLOUT FROM THE CHINESE NUCLEAR EXPLOSION OF JUNE 17, 1967. Reynolds, M. A.; Swindle, D. L.; Wright, R. J.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Science, 158: 1692-3(Dec. 29, 1967).

Low-level activities of ^{131}I, ^{140}Ba, and ^{89}Sr were found in a series of rain samples collected at Fayetteville, Arkansas, during the period from late June through August 1967. The ratios of these short-lived isotopes to ^{90}Sr were determined as accurately as possible. The data indicate that the debris from the Chinese nuclear explosion was injected primarily into the stratosphere. (auth)

10384 ATMOSPHERIC GENERAL CIRCULATION AND TRANSPORT OF RADIOACTIVE DEBRIS. Mahlman, Jerry David. Fort Collins, Colo., Colorado State Univ., 1967. 198p. Thesis.

An attempt is made to explain the physical bases for seasonal and short-term radioactive fallout variations. Previous investigations have shown that large amounts of contaminated stratospheric air enter the troposphere in association with pronounced cyclogenesis at jet stream level. The validity of this mechanism is verified by a statistical analysis of fallout changes compared with 300 mb circulation variations. It was demonstrated that it is not possible to explain the spring fallout peaks on the basis of increased stratospheric-tropospheric mass exchange at that time of the year. Seasonal variation seem to result from characteristics of the stratospheric circulation. Various aspects of the stratospheric transport problem were investigated. Detailed eddy covariance values at 50, 60, and 70°N were computed from 10 January to 20 February 1958 with particular emphasis on the correlation between eddy meridional and vertical wind components. Results indicate that this eddy correlation becomes strongly negative after the polar night vortex breakdown, thus providing a powerful mechanism for northward and downward debris transport in late winter. A computation of the mean meridional cell in the polar night stratosphere was performed by employing a heat budget method. This computation revealed that the mean cell operates in the indirect sense over the chosen period. Eddy temperature flux provided the predominate mechanism for the large temperature increases during the breakdown of the polar night vortex. Mean vertical velocities using a curvilinear system oriented along a line direct sense relative to this reference frame. A comparison was made between the mean amplitude of the vertical motion field at 100 mb and circulation changes at 300 mb. It was shown that the more zonal the circulation at 300 mb, the greater the mean absolute value of the vertical motion field at 100 mb. To investigate the contributions of different motion scales to total stratospheric debris transport, trajectories were determined for the period during and after the polar night vortex breakdown. A pronounced descending motion is associated with northward displacements. Trajectory calculations demonstrate that directional wind shear with height may provide a dynamical mechanism for the apparent total ozone maximum at the base of troughs in the stratosphere. A linear model incorporating the combined dynamic effects of lateral and vertical shear was constructed to analyze the behavior of the polar night vortex. The results show that a necessary condition for instability is that the meridional gradient of potential vorticity must vanish somewhere on an isentropic surface. A comparison was made between the Arctic and Antarctic vortices which revealed that the Antarctic vortex is considerably more stable. It was concluded that this theory may help to explain the differences between the Arctic and Antarctic stratospheric circulations. (Diss. Abstr.)

Mineralogy and Exploration

10385 (CEA-R-3117) GEOLOGIE ET MINERALISATIONS URANIFERES DE LA PLAINE TERTIAIRE DU FOREZ (MASSIF CENTRAL FRANCAIS). (Geology and Uranium Occurrences in the Forez Tertiary Plain (In the French "Massif Central")). Duclos, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1967. 118p. (In French). Dep.

Thesis. Submitted to Univ., Clermond-Ferrand, France.

The observations made during the geological survey of the Forez Tertiary plain (in the French Massif Central) are summarized. Then, using various methods, the formations according to chronology are listed. Finally, a reconstitution of the geological history of the subsidence basin is attempted. The occurrence of 17 uranium bearing geochemical anomalies is commented upon. Each of these various anomalies is given a place on the stratigraphic scale. This enables the successive phases of uranium deposition to be put into their proper perspective in the history of the plain. The usefulness of these uraniferous geochemical anomalies is pointed out. (auth)

10386 (RPI-3836-1) URANIUM GEOCHEMISTRY IN CARBONATES USING THE FISSION TRACK METHOD. Technical Progress Report. Friedman, Gerald M.; Miller, Donald S. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Geology). Dec. 1967. Contract AT(30-1)-3836. 9p. Dep. CFSTI.

Two hundred samples of carbonate sediments from hypersaline, brackish and fresh water environments were analyzed. About 65 samples have been examined for the geochemical behavior of uranium. There appears to be a decrease in the U content with a decrease in relative salinity which is not consistent with data from fresh water environments. (F.S.)

10387 DISTRIBUTION OF RADIOACTIVITY AND OPTICAL PHENOMENA IN DORENAZ COAL (CANTON OF VALAIS, SWITZERLAND). Huegi, Theodor; Jedwab, Jacques (Univ., Bern). Schweiz. Mineral. Petrog. Mitt., 46: 377-87(1966). (In French).

Radioactive rock samples of the permocarboniferous syncline of the Aiguilles Rouges massif near Dorenaz (Valais, Switzerland) were analyzed by chemical, optical and nuclear-plate methods (Ilford K2). The U content of schists and anthracite-rich samples varies from 50 to 590 ppM. Radioactivity generally coincides with petrographic discontinuities (elliptic halos, microstratification) but microfractures do not show any radioactivity. The distribution of radioactivity is illustrated with microphotographs and autoradiographs. Relative age of U introduction is inferred from the observed succession of irradiation and micro-faulting phenomena. (BBB)

10388 DISTRIBUTION OF RADIOACTIVITY AND OPTICAL PHENOMENA IN COAL FROM DORENAZ (CANTON OF VALAIS, SWITZERLAND). Heugi, Theodor (Univ., Bern); Jedwab, Jacques. Schweiz. Mineral. Petrogr. Mitt., 46: 377-87(1966). (In French).

Uranium was determined on the basis of α radioactivity in radioactive rock samples of the permocarboniferous syncline of the Aiguilles Rouges massif near Dorenaz. The samples were analyzed by chemical, optical, and autoradiographic methods. The U content of schists and anthracite-rich samples varied from 50 to 590 ppM. Radioactivity coincided generally with petrographic discontinuities (e.g., elliptic halos and microstratification) but microfractures did not show any radioactivity. The distribution of radioactivity is illustrated by microphotos and autoradiographs. The relative age of introduction of U was inferred from the observed succession of irradiation and microfaulting phenomena. (BBB)

10389 URANIUM DISTRIBUTION IN CERTAIN ALTAY GRANITOID INTRUSIVES. Dolgushin, S. S.; Amshinskii, N. N.

(Siberian Scientific Research Inst. of Geology, Geophysics, and Mineral Resources, Novosibirsk, USSR). Geochem. Int. (Engl. Transl.), 3: 862-6(1966).

Data on the U distribution patterns in some massifs are presented and the possibility of applying these findings to the solution of certain problems of magmatic geology demonstrated. In particular, it was found possible to use them for determining the morphology of intrusives and comparing them with regard to the depth of the erosion section. The distribution pattern of U in granitoids in the Toshtuzek and Belaya Uba massifs of the Altay Kalba complex, which are characterized by uniform tectonic position and established at similar depths, was determined. The Toshtuzek massif has an area of 45 km^2 and is bedded in the sandstone and siltstone of the Barburgaz and Boguta suites (Upper Devonian). The Belaya Uba massif is 450 km^2 in area and occurs in the core of a short anticline extending 50 km. In comparison with the Toshtuzek massif, the Belaya Uba massif is more deeply eroded, as shown by its lack of the apical facies of granite porphyries and fine-grained granites. Uranium distribution was found to be in good agreement with the log-normal law, permitting comparison of the distribution functions of U concentration in the horizontal and vertical directions within each massif, for ascertaining the influence of the sampling-direction factor on the characteristics of the U concentration. This suggested the plausibility of the hypothesis of equality between 2 centers of distribution, of which the statistical evaluations in the lognormal distribution are the geometric means obtained from the vertical and horizontal sampling data. In the Toshtuzek both the U concentration and irregularity of U distribution diminished with depth in the massif and with distance from the apical parts in the vertical and horizontal directions, but the character of the distributional irregularity was somewhat different in 2 massifs. By use of the data obtained on the irregularity of U distribution, a quantitative evaluation of the depth of the erosion section is presented. (BBB)

10390 DISTRIBUTION OF URANIUM IN THE TOURNAISIAN DEPOSITS OF THE WESTERN PART OF THE ORENBURG REGION. Danchev, V. I.; Kuznetsov, V. G. Geochem. Int. (Engl. Transl.), 3: 693-7(1966).

The distribution of U and associated trace elements in the Tournaisian deposits was determined on cores from drill holes in an area of 60,000 km^2 in the western part of the Orenburg province. The average U content, calculated for 192 samples of Tournaisian sediments, was 6.5×10^{-5}%, or about 1/3 that of the average U content in the carbonate rocks of the Russian platform (2.1×10^{-4}%). The lowest U content was 1×10^{-5}% and the highest, 90×10^{-5}%. The distribution of U in the shelf, reef, and basin facies is shown by histograms. This distribution of U was evidently determined by the conditions of sedimentation and epigenetic changes. For example, an important role in the formation of nodular limestones was played by various organisms in the mud. The organic material of the sediment was reworked and absorbed by these organisms. The sediment became lighter in color and more porous, it was thoroughly aerated and had a high redox potential. Under these conditions U formed soluble compounds and did not accumulate in the sediment. This explains why the nodular limestones and nodular argillaceous limestones have the lowest U content. On the other hand, the fine-grained limestones were deposited in the deeper parts of the basins, below the wave base, and the environment of these calcareous muds was favorable for accumulation of U. Uranium was actively removed during some secondary processes, for example, during dolomitization, and, as a result, dolomites had low U content. The character of distribution of U in the different facies depended on the proportion of various rock types. The most typical trace elements associated with U in the carbonate rocks were V, Ni, Co, Cu, Pb, Mo, Be, Zr, and Sr; less common were Nb, Ga, Ge, Ag, and Y. The modern deep sea sediments of the Black Sea, close analogues of the Tournaisian basin facies, contain 4 to 5 times as much U as the oceanic sediments or the well aerated shallow water sediments of the Sea of Azov. The slightly lower U content of the Tournaisian basin sediments (only 3 times higher than in the oceanic sediments) may be ascribed to its lesser depth and absence of hydrogen sulfide. The high content of U and the associated trace elements in the basin facies is explained by intensive accumulation of organic matter in the basin and conditions favorable to its preservation. (BBB)

10391 THE DISTRIBUTION OF U-Th, Na, K, AND Ca IN THE ROTONDO GRANITE. Rybach, Ladislaus; Hafner, Stefan; Weibel, Max (Eidgenossische Technische Hochschule, Zurich). Schweiz. Mineral. Petrogr. Mitt., 42: 307-20(1962). (In German).

Radiometric studies were conducted on the Rotondo granite, a biotite-albite granite of the Gotthard massif. The γ activity and the Na_2O, K_2O, CaO contents of 64 samples of the granite were measured. The U-Th contents of the samples were determined from the γ activity. The western part of the main granite mass showed a clearly higher γ activity as well as a considerably lower CaO content than the other granitic rocks of the Gotthard massif (e.g. Fibbia and Gamsboden gneiss). The core of the main western granite mass was poorer in U-Th and slightly poorer in Na. The eastern extension of the Rotondo granite, the so-called Lucendro and Tremola granites, differed in their U-Th contents from the Rotondo granite; these contents were similar to those of the Fibbia gneiss. (BBB)

10392 MINING IN SITU BY NATURE'S EASY WAY. Eng. Mining J., 168: 75-80(Oct, 1967).

Use of microbiological leaching for extraction of U from low grade ores is explained using as background the bacterial leaching projects being conducted at Stanrock Uranium Mines (Ontario, Canada). The Stanrock operation recovers 15,000 to 16,000 lb U_3O_8 monthly from 1200 stopes having an average floor area of 6000 ft^2 each. Washing of the underground workings is done on 2 shifts a day, 7 days a week. Twelve stopes a day are washed with a repeat cycle every 3 months. So far, some areas have been treated 12 times with no significant drop in extraction efficiency. Scouring with high-pressure solutions, crystal blooming, or oxidation seem to play an important role in exposing fresh surfaces for bacterial attack. During the leaching process visible alterations occur as an indication of the leaching progress. In the first stage, oxidation of sulfides to sulfates produces a dark brown coloration on the walls and floors. As U oxidizes, a bright yellow bloom appears through the brown coating indicating the characteristic color of yellow cake. High-pressure washing (80 to 100 psi) gives the highest U yield, while sprinkling of waste heaps provides a low but consistent output. (BBB)

10393 SIGNIFICANCE AND USE OF OPTICAL PHENOMENA IN URANIFEROUS CAUSTOBIOLITHS. Jedwab, Jacques (Univ. Libre, Brussels). pp 119-32 of Coal Science. Advances in Chemistry Series, No. 55. Washington, D. C., American Chemical Society, 1966.

The effect of irradiation from U mineral inclusions was studied in uraniferous organic materials by microscopic and autoradiographic methods. Optical anomalies were frequently found in uraniferous carbonaceous materials, from different geological ages, such as bituminous and anthracitic coals, coalified logs, bituminous shales, and asphaltic sandstones. These optical anomalies, as seen by high reflectivity and anisotropic halos, are very stable, once acquired, in the course of history of the sediment. Under reflected light the radioactive minerals (zircon, uraninite, coffinite) enclosed in organic material were surrounded by a clear halo of more than 20 μ width. This halo corresponded to a zone of increased anisotropy, reflectivity, and hardness. The reflectivity within the halo was not constant; a maximum was seen close to the radioactive source with a decrease outwards. Tracing of the reflectivity curves with a photocell, recorder, and moving stage showed that the curves may be smooth or sometimes stepwise. Halo width generally varied between 20 and 50 μ, and the intensity of the halos seemed to be proportional to the quantity of U. In asphaltized log samples the uraniferous minerals (uraninite and coffinite) formed minute isolated inclusions, or were aligned according to the cellular structure of the wood. Compressed relics of woody structures were found, together with cellular cavities filled with U, suggesting that U was introduced during or before the compression. The material showed clearly the difference of optical transparency of irradiated zones, and the effect seemed limited to the range of α particles. This does not exclude the effect of the released heat. Nuclear emulsion plates showed that the bulk of the α activity corresponded to discrete inclusions. The asphalt itself showed very low activity. It could not be determined whether the intensity of optical anomalies is cumulative and proportional to the radioactive doses received but it was possible to evaluate by such natural nuclear autoradiographs the time of introduction of uranium, epigenetic vs syngenetic type of its origin, and the plastic and fault-like movements of the organic materials. (BBB)

10394 MICRO-DISTRIBUTION OF RADIOACTIVE ELEMENTS IN POTASSIC ALKALIC ROCKS. Mineeva, I. G.; Korobkov, V. I. Geochem. Int. (Engl. Transl.), 3: 627(1966).

In the alkali rocks investigated, U and Th occurred in independent minerals, intruded into the structure of the accessory minerals, and were dispersed in the rock-forming minerals. Results of autoradiographic investigations confirmed earlier conclusions concerning the relative importance of each form of occurrence of U and Th made on the basis of leaching experiments with the same rocks. Modes of occurrence of U and Th are the same in alkali and granitic rocks, but in granites more than one-half of the U occurred in the rock-forming minerals, while in the alkali rocks the greater part of radioelements was concentrated in the accessory minerals.

Distribution of the α tracks in alkali rocks depends on the predominant mode of occurrence of the radioelements. In the rock-forming minerals (U and Th occurred in a dispersed state) the distribution approximated the exponential law and this was also true of the rocks containing U and Th. The distribution of the radioelements in accessory minerals was nearly lognormal, and in the independent U and Th minerals it was normal. (BBB)

10395 URANIUM EXPORT POLICY. Queensland Govt. Mining J., 68: 198(May 1967).

A policy of the Australian government in conserving U resources by prohibiting U export (except under certain conditions) and promoting exploration for new U reserves is briefly outlined. This policy will insure that sufficient U will be available for essential needs, including the nation's power requirements. In the future, companies will be entitled to export U under conditions that take account of the size of the U ore deposits and/or the date of their discovery. From deposits containing <100 short tons of recoverable uranium oxide, the U may be exported in full. From deposits containing between 100 and 200 tons of recoverable uranium oxide, up to 100 tons may be exported. From deposits containing between 200 and 2000 short tons of recoverable uranium oxide, not more than 50% of the predicted reserves of U may be exported. From deposits exceeding 2000 short tons of recoverable uranium oxide and discovered after January 1, 1967, permission to export more than 1000 tons will be subject to special negotiations. For deposits exceeding 2000 short tons of recoverable uranium oxide proved before January 1, 1967, approval to export any portion of the U will depend on the discovery of new economically recoverable reserves of uranium oxide equal to the quantities for which permission to export is sought. It is expected that this policy will lead to the discovery of additional reserves of U in Australia. (BBB)

10396 POLICY ON URANIUM. Scholes, W. A. Sci. News, 92: 278(Sept. 16, 1967).

Prospects for nuclear power development in Australia and associated regulatory policies on U exploration and export are briefly stated. The Federal Government acted to conserve U resources for Australia's own future atomic energy requirements. Besides restricting exports, it also plans to encourage exploration to locate further U deposits. In the future, companies will be able to export U only under conditions that would take account of the size of the U ore deposits and the date of their discovery. Under new regulations approval to export any portion of the U deposits exceeding 2000 short tons of recoverable uranium oxide proved before Jan. 1, 1967 would depend on the discovery of new economically recoverable reserves or uranium oxide equal to the quantities for which permission to export was sought. Thus some companies, to maintain their U exports, will have actively to search for new U deposits to satisfy this new policy. The Australian Atomic Energy Commission finds that South Australia, because of its high fuel costs, offers the best prospect for the early introduction of nuclear power. It is expected that atomic power stations will be built in Victoria, Tasmania, and New South Wales in the early 1970's. (BBB)

10397 URANIUM PICTURE KEEPS CHANGING. S. Afr. Mining Eng. J., 78: 1823(Aug. 4, 1967).

A survey of the present state of U reserves in South Africa and the likely future course of U demands, as affecting the price of U and need for further exploration of U reserves is discussed. Estimates of installed world nuclear power generating capacity for 1980 are in the 250,000-MW range. In regard to world U reserves, those of the 3 major source countries, the United States, Canada, and South Africa, (at a price of $8/lb) seem to be about evenly split at about 200,000 tons each, taking into account possible additional production in South Africa by new mines. It is evident that these U reserves cannot meet requirements much beyond the early 1980's. If current and future prospecting does not produce appreciable new high grade U mineral occurrences, nuclear power will require higher priced material. So far no significant discoveries have been reported in South Africa. It is against this background that the potential market for natural U is examined. It is possible that a drop in prices in the next years may come about until demand absorbs existing U stocks and world nuclear program undergoes its major expansion. At the same time, it seems likely that consumers will stockpile while U in the $8/ton range is available, though producers will sell appreciable quantities in what is obviously going to be a depressed market of limited U. The tendency seems to be for the negotiation of medium-term contracts (5 to 6 yr), at a fixed price which takes into account a possible decline in the free quotation and a rising one early in the 1970's. (BBB)

10398 SALES TO UTILITIES, HIGHER PRICES, SPARK URANIUM PROSPECTING BOOM. Eng. Mining J., 168: 139; 144(Sept. 1967).

The recent increase of prospecting for U, both in the U.S. and Canada, is described. Exploration drilling in 1967 throughout the U. S. will double the 5-million ft drilled in 1966. The increase in activity stems from rising commercial sales of U to electric utilities, reflecting plans to build nuclear power plants. The commercial sales of U concentrates contracted for delivery in 1971 through 1975 already exceed 7000 tons, and it is expected that this is only a fraction of the ultimate sales which will be made during that time. Another reason for the increased activity is the rising price for U concentrate, now selling for about $7/lb or more, up $1 to $1.50/lb since early in 1966. Unlike the U boom after World War II when many small companies were involved in exploration, large companies, with large amounts of capital, are leading the present search. (BBB)

10399 OBSERVATIONS ON THE Th–U RELATIONSHIP IN ZIRCONS FROM GRANITIC ROCKS AND FROM KIMBERLITES. Ahrens, L. H.; Cherry, R. D.; Erlank, A. J. (Univ. of Cape Town). Geochim. Cosmochim. Acta, 31: 2379-87(Dec. 1967).

Existing data for thorium and uranium in zircons from granitic rocks are discussed, and new data for thorium and uranium in zircons from kimberlites are presented. The new data show that thorium and uranium are at very low levels (from 1.8 to 7.2 ppM for thorium, and from 7.0 to 28.0 ppM for uranium) in kimberlitic zircons, and that the Th : U ratio is just as low (from 0.23 to 0.70) as for granitic zircons. The Th : U ratio in zircons is discussed by comparison with the ratio in igneous rocks, and possible reasons for the low ratio in zircons are suggested. (auth)

10400 TOWARDS MORE URANIUM. S. Afr. Mining Eng. J., 78: 1589(July 7, 1967).

Increased demands for U and its stimulatory effect on U exploration in South Africa are briefly considered. Estimates of nuclear power developments have changed drastically over the last 2 yr so that the world's requirements of U to meet these projects are undergoing drastic reassessment. Since its inception the U industry in South Africa has been a by-product of gold mining, not only on the physical side, but psychologically. For this reason and the fact that only lately have demand prospects changed, intensive exploratory work for new supplies and comprehensive studies of U mining as a primary activity have not been pursued. Uranium production is geared to the output and life of the gold mines and thus the U price must rise sufficiently quickly before gold ore reserves reach the exhaustion point. This provides a further reason for all possible steps being taken to extend the lives of these properties, and justifies the concept of the promotion of U recovery with gold as the by-product. Also needed are ways and means of exploiting smaller ore bodies. There is a tendency in the Republic to disregard any mineral occurrence which does not run into millions of tons and is suitable for large-scale operations. A comprehensive survey of U potential might reveal pockets of payable ore suitable for exploitation on a small scale provided the technical and financial factors are right. The sedimentary deposits outside of the Witwatersrand Triad of U-bearing reefs could fall into the small mine category. (BBB)

10401 THE FUTURE OF THE URANIUM INDUSTRY IN SOUTH AFRICA DEPENDS ON DEVELOPMENT. S. Afr. Mining Eng. J., 78: 1621-3(July 7, 1967).

It was estimated that by 1980 the free world will require 409,000 short tons of UO_2 for nuclear plants. When this is viewed against reasonably assured U reserves in the free world, which in the present economically recoverable $8/lb price range, amount to 595,000 tons, it can be seen that such deposits will not meet requirements much beyond 1980. It has become essential that a more intensive and vigorous prospecting program for U be pursued, not only for extensions of known deposits but also for new deposits. South Africa's role in this respect is discussed. New methods of extraction, which will enable the recovery of U in concentrates below the 0.2 lb/ton grade, make possible the use existing methods of extraction. Large-scale plants, based on the Bufflex and Purlex extraction techniques, are now under construction and research work is being done on further modifications to the solvent extraction process to enable recovery of U below the 0.2 lb/ton grade. Emphasis is being placed on the production of highly refined U hexafluoride, which is the only compound that can be used in the enrichment process. Research by the Atomic Energy Board has developed an alternate process, known as Fluorex, for the production of uranium hexafluoride. Although the technical feasibility of this process has not yet been established, it seems likely that it will enable the production of the compound at a competitive price. A plant has been designed to produce uranium tetrafluoride, which is the first step towards the production of uranium hexafluoride. The Atomic Energy Board

is also actively investigating UO_2 pellet fabrication techniques with the ultimate objective of developing the best and most economical process for South African feed materials. (BBB)

10402 ON THE POSSIBILITY OF PALEOTHERMOMETRY BY THE TRACKS OF FISSION FRAGMENTS OF URANIUM IN MINERALS. Shukolyukov, Yu. A.; Komarov, A. N. (Laboratoriya Geologii, Leningrad). Izv. Akad. Nauk SSSR, Ser. Geol., No. 9, 137-41(Sept. 1966). (In Russian).

An equation is derived for the evaluation of paleothermometry in which t can be correlated with T. Dependence of rate of annealing of tracks on temperature by the tempering method indicates a small dependence of the maximum value on the rate of cooling between 19.6°/min and 4.3°/min, although the maximum comes at different temperatures for muscovite, biotite, and Li muscovite. Temperatures are evaluated for several samples independently dated by the K-Ar method; both direct and graphical methods were employed for various samples. A muscovite sample of the Mamskii region was determined to be deposited at ≤305°K, age 2.5×10^{11} years, apparent age from tracks, 313 million years. Other Li muscovite-biotite, muscovite-biotite, and Li muscovite-muscovite samples have temperatures between 270 and 330°K, with ranges of 30 to 50°K for a given sample; ages of these samples are between 650 and 780 million years. (BBB)

10403 BEHAVIOR OF URANIUM IN PROGRESSIVE METAMORPHISM AND ULTRAMETAMORPHISM AS OBSERVED IN THE WESTERN PART OF THE ALDAN SHIELD. Yermolaev, N. P.; Zhidikova, A. P. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochem. Int. (Engl. Transl.), 3: 716-31(1966).

Attempts were made to trace the redistribution of U in rocks undergoing progressive metamorphism, and analyze the change in the radioactivity of rocks, and to evaluate the role of the principal radioactive components. Data obtained for the Precambrian rocks of the Aldan Shield were compared with the data on the metamorphic rocks of Central Europe and with the published data on the metamorphic rocks of Northern Norway. Thus, U redistribution processes were examined in regional rock metamorphism from amphibolite to granulite facies, and in magmatization and granitization of these rocks exemplified by the Precambrian as well as in processes of metamorphism from greenschist to contact-hornfels facies as illustrated by the Paleozoic of the Erzgebirge. It was evident that during progressive metamorphism rocks lose a part of the U and Th disseminated in them (from 20 to 40% compared to their content in rocks at the preceding stage of metamorphism). The loss of radioelements during metamorphism is correlated with the loss of water and carbon dioxide by rocks. Rocks undergoing regional progressive metamorphism may be considered an enormous potential source of matter for subsequent ore-forming processes. (BBB)

Oceanography

Refer also to abstract 10417.

10404 (CU-3139-1(App.A)) U AND Th SERIES ISOTOPES PROGRAM. Kaufman, Aaron (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). Nov. 1967. Contract AT(30-1)-3139. 16p. Dep. CFSTI.

The concentrations of ^{228}Th, ^{234}Th, and ^{210}Po were studied in a number of samples of surface seawater. The ^{228}Th concentrations were particularly high off northeastern U. S. and northwestern Australia. Concentrations drop off regularly in all directions from the high points. Distribution in the Indian Ocean is zonal. The ^{210}Po is in equilibrium with ^{210}Pb and concentrations were found to be about the same north of 20°N and south of 22°S and are quite similar to the concentration of the grandparent ^{226}Ra. (F.S.)

10405 RADIOACTIVITY OF OCEANIC SUSPENSIONS. II. URANIUM IN OCEANIC SUSPENSIONS. Kuznetsov, Yu. V.; Legin, V. K.; Lisitsyn, A. P.; Simonyak, Z. N. Radiokhimiya, 9: 489-97(1967). (In Russian).

Data are given on the concentration of uranium in oceanic suspensions. The fraction of U in the ocean water, coordinated with the suspensions, was evaluated. The relation between uranium concentration in suspensions and concentration of basic components of the granulometric and chemical states of the suspension was investigated. The direct correlation dependence between $CaCO_3$ concentration and uranium in the suspension was established. (tr-auth)

10406 RADIOACTIVITY OF OCEANIC SUSPENSIONS. III. RADIUM IN THE SUSPENSIONS. Kuznetsov, Yu. V.; Legin, V. K.; Simonyak, Z. N.; Lisitsyn, A. P.; Grashchenko, S. M. Radiokhimiya, 9: 497-500(1967). (In Russian).

The concentration of radium in samples of suspensions collected in different areas of the Indian Ocean was investigated. It was established that the radium concentration in suspension varies within a wide limit from 0.2×10^{-13} to 12.0×10^{-13} g Ra/g of suspension. The spatial distribution of the quantity of radium, correlated to the suspension per unit volume of water of the Indian Ocean, was studied. The values range from 0.1×10^{-16} to 22×10^{-16} g/l. It was found that on an average only 0.3% of the radium in the Indian Ocean is correlated to the suspensions. (tr-auth)

10407 $^{234}U/^{238}U$ IN THE EAST PACIFIC SECTOR OF THE ANTARCTIC OCEAN AND IN THE RED SEA. Veeh, H. Herbert (Yale Univ., New Haven). Geochim. Cosmochim. Acta, 32: 117-19(Jan. 1968).

$^{234}U/^{238}U$ ratios were determined in two composite sea water samples from the Pacific Antarctic (115°W) north and south of 60°S, and in a recent coral from the Red Sea. The respective values 1.13 ± 0.02 and 1.5 ± 0.02 in the Antarctic sea water and 1.15 ± 0.01 in the coral indicate that constancy of the $^{234}U/^{238}U$ ratio is maintained even in remote regions of the oceans. (auth)

10408 THEORETICAL, EXPERIMENTAL, AND FIELD STUDIES CONCERNING MOLECULAR DIFFUSION OF RADIOISOTOPES IN SEDIMENTS AND SUSPENDED SOLID PARTICLES OF THE SEA. PART A. THEORIES AND MATHEMATICAL CALCULATIONS. Duursma, E. K. (International Lab. of Marine Radioactivity, Monaco); Hoede, C. Netherlands J. Sea Res., 3: 423-57(Apr. 1967).

Models were developed to characterize the distribution of waste radionuclides in the sea. Molecular diffusion is not of great importance in the sea, since it is masked by dispersion due to sea currents and turbulent diffusion. However, in 2 areas molecular transport due to the mobility of the molecules is the main process; namely that of the migration of molecules or ions in interstitial water of the bottom sediments, where movement of the interstitial water itself is negligible, and that of the sorption processes on particulate matter, which can be divided into adsorption and absorption. The kinetics of both processes in nature are presented as a diffusion process. The 6 models presented are as follows: diffusion without sorption, diffusion with rapid one-layer sorption, diffusion with slow sorption, diffusion in a 2-layered medium from a constant source, sorption by homogeneous spherical particles from a limited source, and diffusion from a laminar current into a one-layer sediment across a plane surface. It was concluded that the best way to describe the kinetics of the uptake of radioisotopes from sea water by bottom sediments and suspended solid matter is by molecular diffusion. The basic diffusion laws can be applied for finding the important parameter of the diffusion, the diffusion coefficient, which will characterize the migration of radioisotopes in sediments, and the kinetics of the sorption into solid suspended matter. The theoretical approach presented takes in several situations, for which the relation between concentration with time and distance, or total uptake with time is calculated. (BBB)

10409 OCEANOGRAPHIC STUDIES DURING OPERATION WIGWAM: ZOOPLANKTON INVESTIGATIONS. Bieri, Robert (Scripps Inst. of Oceanography, La Jolla, Calif.). Limnol. Oceanogr., 7: Suppl., 29-31(1962).

A survey of zooplankton was made in the Pacific Ocean near the point of detonation of a nuclear device in the course of Operation Wigwam. Zooplankton was brought into the nuclear test area by currents from the north. Because of the decrease in current velocity with increased depth, organisms living in the upper layers passed through the area more rapidly than those living deeper. Animals that migrated vertically passed through the area at an intermediate rate. Estimates were made of the amount of zooplankton in these 3 categories. Nylon nets used in radioactive water came up with activity readings as high as 5000 cpm (~1 mR). Dragging an unmounted contaminated net at 10 knots for 1 hr in uncontaminated water did not reduce its radiation significantly. One tow was made in a layer of radioactivity by attaching a 1-m net just above the vertical telemetering probe and by opening and closing it while the probe was kept in the thin layer of activity (8-m thick). Thus it was possible to record the depth of tow, and the temperature and radioactivity of the water at that depth. Three plankton species were sometimes conspicuous at the surface during the day in the nuclear test region. Valella was most common; pelagic barnacles, Lepas, and galatheid decapods, Pleuroncodes, were seen occasionally. With few exceptions copepods dominated the samples. Radiolarians, Noctiluca, ostracods, chaetognaths, and euphausiids followed in abundance in that order. (BBB)

10410 OCEANOGRAPHIC STUDIES DURING OPERATION WIGWAM: INTRODUCTION AND SUMMARY. Schaefer,

Milner B. (Scripps Inst. of Oceanography, La Jolla, Calif.). Limnol. Oceanogr., 7: Suppl., 3-6(1962).

Introductory remarks are presented as well as summaries of various oceanographic studies made preliminary and subsequent to a nuclear test (Operation Wigwam). They were conducted in the high seas southwest of California in association with an underwater test of a nuclear fission device. Before this test, to enable the selection of a site which would involve no hazard to man through contamination of fishery products, studies in physical, chemical, and biological oceanography of a large sea area, within which such a site might be located, were conducted. Lab studies were also made of uptake of various radioisotopes by organisms at different tropic levels. Further detailed field studies were made up to the data of the test, and additional field and lab studies were made following the test to monitor its effects. On the basis of the preliminary investigations, a site was chosen near 29°N latitude and 126°W longitude which satisfied logistic and also safety requirements. This location is in a biological desert, some distance from any commercial fishing areas, where transport of radionuclide-contaminated water is away from fishing grounds. Subsequent monitoring of fish in commercial catches from fishing areas most nearly adjacent to the test site, and elsewhere, revealed no evidence of contamination. (BBB)

10411 OCEANOGRAPHIC STUDIES DURING OPERATION WIGWAM: PHYSICAL OCEANOGRAPHY OF THE TEST AREA. Horrer, Paul L. (Scripps Inst. of Oceanography, La Jolla, Calif.). Limnol. Oceanogr., 7: Suppl., 7-26(1962).

Physical oceanography studies were conducted in association with Operation Wigwam, principally to trace the drift of radioactivity after the detonation of an underwater fission device in the Pacific, southwest of California. Methods of indirectly determining currents included computation of currents from the distribution of density as computed from temperature and salinity, and qualitative inferences as to currents which would account for special features of the observed distribution of such properties as temperature, salinity, and dissolved oxygen content of the water. The pattern of currents over the whole area was computed by the former method and to some extent substantiated by the latter procedure. Direct measurements were made of the drift of radioactive waters. As Ground Zero was approached after the shot, 4 quick-launching drum-contained parachute drogues were thrown overboard at distance intervals of 1 mile each. The chutes were at a depth of about 5 m. Five deeper drogues were also launched. Data obtained on both groups are shown. Approximate tracks of the masses of drifting radioactive waters were drawn, based on radiation probe data and drogue movements. A position of the surface and near-surface radioactivity, at D + 40 days is also shown. The results showed that up to D + 3 days the radioactivity drifted in a southwesterly direction, and between D + 3 and D + 5 changed to a northwesterly course. (BBB)

Seismology

Refer also to abstract 12207.

10412 (NVO-1163-93) PROCEDURE FOR RECORDING GROUND MOTION VELOCITY FROM UNDERGROUND NUCLEAR EXPLOSIONS. Watson, D. L. (Environmental Research Corp., Alexandria, Va.). Aug. 4, 1967. Contract AT(29-2)-1163. 45p. CFSTI.

The overall procedure for obtaining records of ground motion resulting from underground high explosive or nuclear explosions is described. The procedure used to calibrate and prepare these data for presentation to other contractors is detailed. This procedure is limited to data obtained with National NC-21 velocity meters. (auth)

10413 P TIMES TO AUSTRALIAN STATIONS FROM NUCLEAR EXPLOSIONS. Cleary, John (Australian National Univ., Canberra). Bull. Seismol. Soc. Amer., 57: 773-81(Aug. 1967).

Data for seismic wave arrivals in Australia from nuclear explosions were compared with those based on recent analysis of P times to North American stations from 25 earthquakes, obtained by statistical techniques to separate source and station effects from average travel times. P travel times and station terms found for earthquakes gave scattered results when applied to times to Australian stations from nuclear explosions at Bikini and Eniwetok. The Australian station terms were amended using data from LONGSHOT, and this helped to eliminate most of the earlier discrepancies. However, the times to 2 stations at distances of about 35° and 40° from the Marshall Islands explosions were about 0.4 sec earlier than those predicted from earthquake data. Two Bikini explosions gave significantly earlier times than the other events, an effect largely explicable in terms of the known structure beneath the atoll. The Australian station terms showed regional features similar to those observed elsewhere, notably negative terms in shield areas and positive terms in areas of recent tectonic uplift. (BBB)

10414 MAGNITUDE DETERMINATION AT REGIONAL AND NEAR-REGIONAL DISTANCES IN THE UNITED STATES. Evernden, J. F. (USAF Technical Applications Center, Washington, D. C.). Bull. Seismol. Soc. Amer., 57: 591-639(Aug. 1967).

Seismic data obtained from nuclear explosions and earthquakes were used to examine some problems of variation of P_n amplitudes in the regional and near-regional distance ranges (200 to 2100 Km). The data used were recorded by Long Range Seismic Measurement vans of the VELA Seismological Center. Records obtained during the following shots were analyzed: DORMOUSE, MISSISSIPPI, CIMARRON, STILLWATER, CODSAW, MINK, HAYMAKER, DES MOINES, MARSHMALLOW, MADISON, BILBY, and HARDHAT. It was shown that the patterns of P_h amplitudes versus epicentral distance (Δ) in Western U. S. and Eastern U. S. are markedly different and that these differences are related to different velocity structures in the 2 regions. These differences extend to at least 150 Km depth. Neither the Western nor Eastern U. S. amplitude patterns conform to that predicted by Guterberg and Richter in the 1000 to 2000 Km range. It is now possible to make consistent estimates of magnitude at all distance ranges for most nuclear explosions and earthquakes. Obtaining consistent estimates of amplitude as a function of distance for a particular event requires a knowledge of the energy distribution between the several refracted phases used between 200 and 2500 Km distance. (BBB)

10415 SEISMIC WAVE ARRIVALS FROM LONGSHOT, 0° TO 27°. Carder, D. S.; Tocher, Don; Bufe, Charles; Stewart, S. W.; Eisler, Joseph; Berg, Eduard (Inst. of Earth Sciences, San Francisco). Bull. Seismol. Soc. Amer., 57: 573-90(Aug. 1967).

The longshot experiment, an underground nuclear explosion on Amchitka Island, was used to evaluate seismic wave propagation from sources in the Aleutian Island arc. In the distance range considered, from 2.6 to 26.6° from ground zero, useful records were received from 27 stations in Alaska and 2 in Yukon Territory. Seismic wave arrivals were recorded at all 29 locations. Five of these stations were on the island chain, 3 on the Alaskan Peninsula, 2 on other islands, and the remainder on the mainland from Anchorage to Point Barrow. The upper mantle travel times to distances of about 11° could be represented by $t = \Delta(\text{Km})/7.85 + 4.9 \pm 0.5$, where Δ is epicentral distance. The estimated depth to the M discontinuity beneath the island chain was from 22 to 26 Km depending on the choice of data. In the distance range from 6° to 16°, recognition of the initial P wave could be a function of the signal-to-noise ratio. From 13° to 27°, travel times averaged from 1.5 to 4.0 sec earlier than the Jeffreys-Bullen (JB) surface-focus travel times with a steep gradient from "early" in central and northern Alaska to an average of 2 sec "more early" in eastern Alaska including Circle Hot Springs, Anchorage, and Kodiak. PcP arrivals were recognized at 15.5° and beyond, and their travel times were parallel to the JB PcP times but from 2 to 4 sec earlier. PcP was not anomalously early at Kodiak as was P. P wave amplitude maxima to the Bering Sea stations of St. Paul Island and Cape Romanzoff were an order less than at like distances on the Peninsula. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 10409–10412, 10414, 10415, 10637, and 12210.

10416 (FOA-4-4327-28) STUDIES OF DEBRIS PARTICLES FROM THE FOURTH AND FIFTH CHINESES NUCLEAR TESTS. Sisefsky, J. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov. 1967. 8p. Dep.

Nuclear debris particles from the fourth and fifth Chinese tests in 1966 collected in air samples were examined by reversal autoradiography and microscopy. The particles from China IV are yellow and resemble those from China II. The particles from China V are mostly colorless, an orange-black, usually large, and with very low specific activities. There are also a small fraction of red particles with higher specific activities. China V particles show strong chemical resistance. (auth)

10417 (NVO-289-1) RUN-UP OF NONBREAKING WAVES. Final Report. Le Mehaute, Bernard; Hwang, Li-San; Divoky, David; Koh Robert; Butler, H. Lee; Lin, Albert (Tetra Tech, Inc., Pasadena, Calif.). Aug. 1967. Contract AT(26-1)-289. 147p. Dep. CFSTI.

Experimental and theoretical investigations are described for run-up of nonbreaking waves. The run-up of nonbreaking waves of small steepness on gentle slopes, establishment of breaking criteria for such waves, and investigation of the difference in the two items between periodic and nonperiodic waves such as the waves resulting from underground explosions were investigated. (F.S.)

10418 (NVO-1163-88) STATISTICAL RELATIONSHIP BETWEEN BAND-PASS FILTER AND PSEUDO RELATIVE VELOCITY SPECTRA. Final Report, Revised. Lynch, R. D. (Environmental Research Corp., Alexandria, Va.). Aug. 9, 1967. Contract AT(29-2)-1163. 26p. CFSTI.

Empirical data from four events are analyzed statistically to determine an amplitude relation between pseudo relative velocity and band-pass filter spectra. Amplitude ratio data are analyzed on the basis of component, event, and four combined events. From the entire sample (1673 readings) the amplitude ratio has a mean of 8.57, a standard deviation of 2.45, and a normal distribution about the mean. The results of the analysis indicate the possibility of predicting pseudo relative velocity spectra from predicted band-pass filter data. Subsequent analysis for other stations and other events has given results which are consistent with the data presented. (auth)

10419 (SC-RR-67-727) CRATER FROM AN INDIVIDUALLY DETONATED MULTIPLE-CHARGE ARRAY. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. 56p. Dep. CFSTI.

Air blast and seismic safety considerations may not always permit efficient excavation by simultaneous detonations. To determine whether comparable excavation could be achieved by detonating smaller charges one at a time (nibbling), twenty-five 64-pound charges in a special array were detonated one at a time, followed by a similar detonation of eleven more charges at a row in the bottom of the crater formed by the first twenty-five. The results prove conclusively that in principle nibbling will work to reduce source strength while achieving an excavation goal. The nibbling method provides nearly 50 percent less crater volume than a single charge because of backfilling from subsequent detonations. (auth)

10420 (TID-24191) GROUTING IN SUPPORT OF UNDERGROUND NUCLEAR TESTING. Miscellaneous Paper No. 6-914. Bendinelli, R. A.; Burnett, W. L. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Apr. 1967. Contract AT(29-2)-752. 29p. Dep. CFSTI.

The development and the placement of grouts in support of underground nuclear experiments is described. Support consists of consultation services for grouting programs; development of grout mixtures to meet experimental requirements, i.e., stemming of nuclear devices in deep drilled holes; coupling to formations associated instrumentation emplaced in deep holes drilled in various rock and alluvium formations; as massive plugs in shafts and tunnels; as shock-mitigation material behind tunnel liners, etc. Problems experienced and resolution of such problems are described. (auth)

10421 SAFETY WITH NUCLEAR EXPLOSIVES. Hamburger, Richard. S. Afr. Mining Eng. J., 78: 2129-30 (Sept. 8, 1967).

Problems of reducing hazards of release of radioactivity into the environment in the Plowshare program are discussed, with emphasis on the possible use of nuclear explosives in the construction of a sea-level canal. There are 3 major problems which must be considered in determining the feasibility of excavating a sea-level canal with nuclear explosives including whether nuclear excavation can be used in such a manner as to result in an acceptable engineering product, whether it can be done safely, and whether it is economical. Safety feasibility analysis must include the identification of those effects of the nuclear explosion which might be hazardous: the assessment of these effects to determine if they do present possible unacceptable hazards to man and his environment; ways to avoid or control those effects which might present possible hazards; and an estimation of the operational costs associated with these measures. In determining safety feasibility, an evaluation must be made to show that the design of the project is such that the safety definitions given can be fulfilled. This requires consideration of meteorology, geology, seismology, hydrology, structural response to ground motion, acoustic waves, radiation, and the biological and ecological systems. Various organizations given responsibilities for evaluation of such factors are enumerated. (BBB)

10422 RECOVERING OIL BY RETORTING A NUCLEAR CHIMNEY IN OIL SHALE. Lombard, D. B. (Lawrence Radiation Lab., Livermore, Calif.); Carpenter, H. C. J. Petrol. Technol., 19: 727-34 (June 1967).

A method is proposed for recovering oil by retorting oil shale shattered by deep underground nuclear explosions. Because most of the oil will be obtained from chunks of oil shale with maximum dimensions exceeding 1 ft, retorting times of up to several weeks are needed for complete recovery. A study of the heat economy of the retorting process in an underground nuclear chimney suggests that the nuclear detonation itself and the subsequent controlled combustion of residual carbon in retorted oil shale will provide ample energy. The proposed method is shown to be thermally efficient. The operating conditions of a nuclear chimney retort will be defined by the recycle gas-to-air ratio and the overall rate of gas injection. Determination of optimum operating conditions will be complicated by the many factors involved. However, the proposed technique appears to be a promising one for recovering the oil from thick, deep, oil shale deposits. (BBB)

10423 PROJECT THUNDERBIRD: A NUCLEAR TRIGGER FOR COAL GASIFICATION. Wold, John S.; Woodward, Thomas C. (Wold and Jenkins, Casper, Wyo.). Coal Age, 72: 64-5; 68 (Sept. 1967).

Use of nuclear explosions to facilitate utilization of coal, oil shale, and bituminous sand beds is reviewed, with particular attention to Project Thunderbird. A 100-mi^2 region of Wyoming, underlain by more than 20,000 million tons of coal, is the site for this in situ coal-energy experimental program. The total coal interval lies at a depth of from 1000 to 2200 ft and contains a gross section of coal that may be the thickest in the Western Hemisphere. In Project Thunderbird, a nuclear explosion will open up multiple seams and overcome some problems experienced in previous underground gasification experiments. A collapse chimney of 25 to 30% void space could be formed, which would be burned under controlled conditions. A 50-kiloton nuclear device at 2200 ft in the base of the Fort Union coal-bearing unit will give the following chimney characteristics: a rubble chimney of broken rock with a radius of about 127 ft and a height of around 635 ft; fractures extending into the surrounding formation in a radius of 300 ft; and approximately 2,000,000 tons of broken rock of which 25% (or 500,000 tons) is coal (a Btu equivalency of 1.5 million barrels of oil). Ignition of the broken coal and controlled injection of oxygen into the chimney will produce low-Btu gas and associated products. (BBB)

10424 PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIVES: PLOWSHARE. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION, JANUARY 5, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 623p. GPO $2.00.

PLOWSHARE PROJECT—review of
ATOMIC ENERGY COMMISSION (USA)—Plowshare program development
NUCLEAR EXPLOSIONS—peaceful applications of (H.D.R.)

10425 NUCLEAR WEAPONS. Berzins, Otto New York, Hart Publishing Co., Inc., 1967. 153p. $5.00.

The effects of nuclear weapon explosions and steps which may be taken to minimize the effects of radiation from such explosions are discussed. Elementary facts about nuclear energy, general principles of nuclear weapons, typical nuclear explosions, blast waves from nuclear explosions, thermal and ionizing radiation, and protective measures against the effects of nuclear explosions are discussed. Collective and individual blast and fallout shelters are illustrated and reviewed. (F.S.)

Facilities and Equipment

Refer also to abstracts 10509, 10510, 10515, 10602, 10649–10651, 10945, 11293, 11297, 11339, 11346–11352, 11363–11366, 11370–11373, 11375–11379, 11403, 11406, 11412, 11413, 11512, 11798, 11856, 11858, 12168, 12169, 12187, 12191, and 12217–12219.

10426 (AAEC/TM–347) RADIATION FIELD CHARACTERISTICS AND IRRADIATION TECHNIQUES FOR GAMMA IRRADIATION FACILITIES USING SPENT FUEL ELEMENTS FROM THE REACTOR HIFAR. O'Leary, B. M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1966. 15p. Dep.

Experimental and service gamma irradiations of various small volume or bulk materials can be carried out at Lucas Heights by using an array of spent fuel elements from the reactor HIFAR in an irradiation pond. Details of the gamma radiation fields available are given and the irradiation technique are described. These include experimental irradiations at low, ambient, and above-ambient temperatures. Geometrical factors which affect the dose rate are taken into account to ensure that the materials receive the specified dose. (auth)

10427 (ANL–7364) ELECTRON-BOMBARDMENT-HEATED SODIUM EXPERIMENT. Holtz, Robert E. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 57p. Dep. CFSTI.

Experimental electron-bombardment-heating (EBH) data pertinent to the construction of a high-heat-flux, transient electron-bombardment heater is presented. Testing with both pure-tungsten and uncarburized-thoriated-tungsten, 0.030-in.-dia cathodes supplied heat fluxes of up to 371,000 Btu/hr-ft^2 to the inside surface of a $\frac{3}{4}$-in.-dia, Schedule 160 pipe (anode). Plots are presented showing the effects of geometry, accelerating voltage, cathode temperature, diode vacuum, and cathode material upon the electron-emission current. Curves showing the EBH behavior during transient testing are also shown. (auth)

10428 (BDX–613–99) ZIPPERED MANDRELS. Willerton, V. L. (Bendix Corp., Kansas City, Mo.). Dec. 1967. Contract AT(29-1)-613. 9p. Dep. CFSTI.

The zippered mandrel is a removable mandrel designed to hold cylindrical or elliptical forms for machining, coating, and forming. The zipper permits mandrel removal without disturbing the final product. (auth)

10429 (CEA–R–3364) TAILLES ET LOCALISATIONS OPTIMALES DES USINES DE RETRAITEMENT DES COMBUSTIBLES NUCLEAIRES. (Optimal Sizes and Siting of Nuclear Fuel Reprocessing Plants). Thiriet, Lucien (Commissariat a l'Energie Atomique, Paris (France)). Sept. 1967. 120p. (In French and English). Dep.

The expansion of a nuclear economy entails the development of fuel processing and reprocessing plant programs. The model proposed makes it possible to select the size, siting, and start-up schedule of the plants in such a way as to minimize the total freight and reprocessing costs. The method consists in first approaching the process plant problem as a Dynamic Programming problem, increasing program slices being explored sequentially. When the quantities of used natural uranium to be reprocessed are fixed, the minimization of the transport cost is then carried out as a dynamic programming problem. The optimum process cost is explored in order to find the minimum optimal processing cost and corresponding optimal transport cost. As the reprocessing problem can be represented on a sequential graph, in order to compute the sub-optima, a "reflection algorithm" was developed. The method can be interpreted as a general mechanism for determining the optimum when to a sequential dynamic problem (for example an equipment program) is added a complementary problem. It also makes it possible to estimate the economic losses which result from the choice of a non optimal policy for other than economic reasons. (auth)

10430 (EURAEC–1762) UN PROBLEME METALLURGIQUE NON RESOLU: LE RECUIT DE DETENTE DES CUVES POUR REACTEURS NUCLEAIRES. (An Unsolved Problem in Metallurgy: Stress-Relief Annealing of Nuclear Reactor Vessels). Sebille, J. (European Atomic Energy Community). Dec. 8, 1966. 23p. (In French). (EUR–3317; CONF–661047–1). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

From Conference on Experts on Recurring Inspection of Nuclear Reactor Pressure Vessels, Pilsen, Czechoslovakia.

The metallurgical aspects of stress-relief annealing requires supplementary research, the results of which demonstrate both its advisability and importance from the standpoint of vessel properties and safety. (auth)

10431 (HUX–3807–1) FLOATING ROOF CONTAINMENT VESSEL. Progress Report, September 1966–August 1967. First, Melvin W.; Bulba, Eli (Harvard School of Public Health, Boston, Mass.). July 1967. Contract AT(30-1)-3807. 4p. Dep. CFSTI.

A 500 ft^3 pilot scale model of a floating roof containment vessel was constructed. The vessel has a heating jacket, shaft and Teflon bearings, floating roof and two covers. The air delivery system was assembled and testing was started. A testing machine was designed to determine static and dynamic friction in the lubricant. (F.S.)

10432 (K–1682) TIP CLEARANCE PROBLEMS IN AXIAL COMPRESSORS. (A SURVEY OF AVAILABLE LITERATURE). Reeder, John A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Jan. 4, 1968. Contract W-7405-eng-26. 62p. Dep. CFSTI.

A literature survey of the problems of tip clearances in axial compressors was made. No attempt was made to weave the various reports surveyed into a general theory. An attempt to bring into focus the salient features of all the surveyed investigations was made. This survey represents most of the investigations that were reported in the open literature up to the middle of 1966. (auth)

10433 (LA–3782) SODIUM PUMPS IN THE LOS ALAMOS 2000-KILOWATT SODIUM TEST FACILITY. Melton, B. J. (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Design and performance data for two sodium pumps used in the 2000-kW sodium test facility at the Los Alamos Scientific Laboratory are discussed. These were multistage centrifugal pumps with sodium-lubricated hydrodynamic shaft bearings and oil-lubricated mechanical face seals. The primary pump was operated for 11,920 hr with no down time for maintenance after the first 2 weeks of operation. The secondary pump was operated for 13,374 hr with no down time for maintenance. Postoperational inspection of secondary pump components revealed no undue wear or evidence of incipient failure. (auth)

10434 (LA–3814) MICRORADIOGRAPHY OF PYROCARBON-COATED $^{238}PuO_2$ MICROSPHERES TO DETERMINE COAT THICKNESS. Morris, R. A.; Strong, R. D. (Los Alamos Scientific Lab., N. Mex.). Oct. 6, 1967. Contract W-7405-eng-36. 6p. Dep. CFSTI.

A method of microradiographing pyrocarbon-coated PuO_2 microspheres without contaminating the plate and the radiographic equipment is described. Resolution of the order of one micron has been obtained. The equipment and the technique used are discussed. (auth)

10435 (MND–3169–66) SNAP 19 PROGRAM. EJECT MECHANISM COLD WELDING EVALUATION. Podlaseck, S. (Martin-Marietta Corp., Baltimore, Md.). May 1965. 12p. Dep. CFSTI.

Cold welding under combinations of natural and artificial environments to which the SNAP-19 eject mechanism will be exposed was studied. It was felt that the application of a dry film coating, such as MoS_2, to the piston and upper spring assembly would eliminate problems of interfacial contact in the eject mechanism for the 5-year lifetime of the assembly. (F.S.)

10436 (MND–P–2173(Rev.2)) PROGRAM PLAN, TASK 3, SNAP III. NUCLEAR THERMOELECTRIC GENERATOR DEVELOPMENT. (Martin-Marietta Corp., Baltimore, Md.). Jan. 27, 1960. Contract AT(30-3)-217. 6p. Dep. CFSTI.

The development of devices for converting the thermal energy of a radioisotope into electrical energy continues. Parametric tests were run on the 3M1G3 test thermoelectric generator until it failed. General indications were general deterioration with considerable sublimation of lead telluride, which was indicative of overheating the hot junctions. A new test procedure was prepared. (J.C.W.)

10437 (NAA–SR–12534) LIQUID-METAL-HEATED STEAM GENERATOR OPERATING EXPERIENCE. Budney, G. S. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Nov. 1, 1967. Contract AT(04-3)-700. 168p. CFSTI.

The operating experience of liquid-metal-heated steam generators applicable to liquid-metal-cooled fast breeder reactor power plants is presented. The steam generators reviewed are those tested under the SIR program, small-scale steam generators tested in support of experimental and prototype nuclear power plants, the experimental and prototype nuclear plant units, and the model steam generators to be tested in the Sodium Components Test Installation (SCTI). The materials, design, and operating characteristics are described with emphasis on those features that affect the structural integrity of the steam generators. The failures that have occurred are described and the probable cause of failure and solution are discussed. (P.G.C.)

10438 (NAA-SR-12585) LIQUID METAL ENGINEERING CENTER (LMEC) QUARTERLY TECHNICAL PROGRESS REPORT, JULY-SEPTEMBER 1967. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Nov. 15, 1967. Contract AT(04-3)-700. 101p. Dep. CFSTI.

Progress in the development of engineering standards and practices for liquid metal systems and components is reported. Histories of sodium loop, valve, and pump failures are shown with recommendations for corrective action. Other activities such as monitoring and investigations of corrosion build-up, fuel handling devices, control rod drives, and fuel holddown mechanisms for sodium-cooled fast breeder reactors are described. Also discussed are results of studies on sodium flow-instrumentation and on development of electric resistance strain gages and transducer devices employing strain gages in or out of a sodium environment. (P.G.C.)

10439 (SC-CR-67-2627) ANALOG MODEL OF WAVE PROPAGATION IN OPEN AND CLOSED END CYLINDER PHASE II OF AN INVESTIGATION OF "ANALOG STUDY OF IMPACT FRACTURE OF CLOSED-END CYLINDERS." Ju, F. D.; Wambold, J. C. (New Mexico Univ., Albuquerque). Apr. 1967. 251p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

An analog computer program is provided whereby the design engineer can get an expedient answer as to the safe impact velocity allowed with no initiation of a crack for a circular hollow cylinder, with and without an end cap. Included is a general program in which the shape parameters (wall thickness, end cap thickness, and overall diameter) are put into a digital program, the potentiometer values are calculated and with these potentiometer values set into the analog, the solution for this shape is available. A brief example of the use of this general program is also given. (auth)

10440 (UCRL-13331) ULTRASONIC WELDING OF METALS IN VACUUM. Final Report. Pfaelzer, P. F.; Frisch, J. (California Univ., Berkeley. Coll. of Engineering). Dec. 1967. Contract W-7405-eng-48. 65p. (MD-67-3). Dep. CFSTI.

For Univ. of California, Lawrence Radiation Lab., Livermore.

Ultrasonic welding of copper was performed in air as well as in 10^{-10} torr vacuum environment. Adhesion between contacting surfaces was greatly enhanced by the vacuum environment, as shown by the higher coefficients of adhesion. Test results show that the strength of welds depends on the interfacial areas which have not slipped relative to each other. Microscopic details of the weld topography show a recurrence of distinct areas which affect the weld integrity. In the presence of oxidation, slip areas are not considered as a useful condition for high bond strength. (auth)

10441 (UNC-5189) PERFORMANCE EVALUATION OF HEAT EXCHANGERS FOR SODIUM-COOLED REACTORS. Quarterly Technical Progress Report, July 1-September 30, 1967. Israel, S. L.; Nolan, D. J.; Malmborg, F. B. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Sept. 20, 1967. Contract AT(11-1)-1452. 47p. Dep. CFSTI.

The evaluation of the thermal-hydraulic and structural performance of heat exchangers for sodium-cooled reactor plants is discussed. The evaluation is based on the results of tests of model heat exchangers [approximately 30 Mw(t)] in the Sodium Components Test Installation (SCTI). An intermediate heat exchanger and a steam generator were tested. A parametric study was performed to establish the operating conditions for reduced feedwater temperature tests of the units. The results of this study are tabulated. Further comments were made on a test plan for establishing the effects of gas entrainment on heat transfer characteristics and on procedures for conducting tube vibration tests. Procedures for the structural evaluation of the units are being shaken down with the aid of "rise-to-power" test data. Predicted temperatures in the critical tubesheet areas are compared with measured values. Tubesheet stresses were calculated for a large range of tubesheet temperature differences. Stresses are considerably lower than code allowable values for the maximum specified tubesheet temperature differences. The effects of certain assumptions on tubesheet temperature distributions during transients were evaluated. Strain gage test results and plans for the steam generator were reviewed. (auth)

10442 ^{60}Co IRRADIATION FACILITY OF THE L. YA. KARPOV PHYSICAL CHEMISTRY RESEARCH INSTITUTE. Gerrard, Martha (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 5: 59-60(Fall 1967).

The KP-140 irradiation, designed and fabricated at the L. Ya. Karpov Physical Chemistry Research Institute, Moscow, is described. The irradiator contains 200 kilocuries of cobalt-60. The source is made of 81 × 11 mm dia cobalt-60 pellets. (R.C.K.)

10443 SOME PROBLEMS OF THERMAL SCHEMES AND AQUEOUS REGIMES IN ORDINARY AND NUCLEAR POWER STATIONS. Margulova, Tereza H. Nukl. Energ., 3: No. 6, 16-21(1966). (In Serbo-Croatian).

Purification of the feed water represents a very important problem for both conventional and nuclear power plants. The behavior of iron and copper oxides in the water circuits of a power plant is examined on the basis of experience gained with conventional systems and under consideration of the results of research carried out at the Moscow Institute for Energy Generation. The most effective methods for removing these impurities are reviewed, indicating that the orientation of the steam generators exerts a strong effect on the removal process. Horizontal geometry facilitates the removal of corrosive materials, while vertical arrangement renders this task more difficult. Special attention must be given to the prevention of the entry of oxygen into the steam-generating portions of the plant because the amount of oxides present is strongly dependent on the availability of oxygen in the system. Care must be taken to prevent leakage of condensers and suction effects. (TTT)

10444 COMPETITIVE NUCLEAR-POWERED MERCHANTMAN. Teasdale, J. A. (Univ. of Newcastle-upon-Tyne, Eng.). Engineer, 224: 185-6(Aug. 11, 1967).

The design of nuclear-powered merchant ships is considered, with emphasis on the following 6 types: composite type, general cargo, perhaps with some unitization; composite type, container; integral type, high-powered container; composite type, bulk cargo, liquid or dry; integral type, high-powered passenger liner; and integral type, high-powered bulk cargo, liquid or dry. A detailed investigation into the separable concept applied to deep-sea service, in conjunction with both conventional and nuclear propulsion plants is suggested. For the nuclear power source, the almost continuous utilization of one pusher ship in conjunction with a basic fleet of 3 cargo units on a circular trade route, i.e., one in each terminal port and one in transit, could produce substantial saving in both capital and operating costs over the equivalent number of integral ships. It is possible to achieve a practical equivalence factor of up to about 2.8 integral ships to one composite fleet unit. The conceptual cost saving for the proposed design of a 13,000-tons deadweight, 21-knot composite cargo liner could more than pay for the cost of a nuclear reactor plant for the required power output of about 22,000 hp. To justify the application of nuclear power in a merchantman by primary argument on cost alone is encouraging. (BBB)

10445 COST OF WATER FROM NUCLEAR DESALINATION PLANTS. Engineer, 224: 190-1(Aug. 11, 1967).

Cost estimates are given for dual-purpose plants in which desalination equipment is operated with low-grade waste heat from nuclear power stations. Such plants use sea water as feedstock and apply low grade heat from the power station turbines to operate multi-stage flash evaporators and thus produce potable water and electricity at competitive prices. By combining power generation with distillation, the reactor has to be of a larger size than if it were built solely for the required power generation. This produces a beneficial scale effect, enabling the combination to operate at an even lower reactor cost per kilowatt of heat than would be obtainable from a single-purpose power reactor of comparable electrical output. This gain is in addition to the economic advantages of using low-grade heat from back pressure or pass-out turbines. Data are based on the principle that the saving in reactor cost be credited to the power generated. Competitive water costs can be obtained by the combination of large nuclear power stations of 1000 MW or more and large distillation plants of at least 50 Mgd. (BBB)

10446 ECONOMIC FRESH WATER FROM THE SEA. Engineering, 204: 136(July 28, 1967).

An economic analysis of the use of existing nuclear reactors for desalination is reported. The analysis was conducted on behalf of the International Atomic Energy Agency. The report considered light-water, gas-cooled, and fast-breeder reactors, along with fossil-fueled boilers. Condensing, pass-out, and back-pres-

sure turbines were considered for the generating plant, and the size of reactor taken was 300 to 5000 MW(t). The plant sizes considered were for outputs of 5, 10, 20, and 50 Mgd. The combination of production of both electrical power and fresh water results in a beneficial economy of scale for the reactor designer, the cost of heat produced being lower than for either a straight distillation plant or a power station. This gain is in addition to the accepted economic advantages of using low-grade heat from back-pressure or pass-out turbines. The main conclusions of the report are that competitive water costs can be obtained by the combination of large nuclear power stations of 1000 MW or more, and distillation plants of at least 50 Mgd. The economic potential will be enhanced with the introduction of fast-breeder reactors, which could cut costs by as much as 30% with electricity costing around 0.25d per kWh. (BBB)

10447 IRRADIATION EQUIPMENT FOR FAST-BREEDER CANNINGS. Kramer, W.; Schmidt, L.; Will, H. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 9: 499-502(Nov. 1967). (In German).

A facility is described, which allows examination of the long-time behavior under irradiation of several high-temperature-resistant alloys in form of small tubes. With controllable temperatures up to 800°C the specimens may be loaded up to an internal pressure of 500 kgf/cm^2. The design of the irradiation facility that contains the irradiation rig with specimens, the temperature-control device, and the pressure supply, is described in detail taking also into account special problems resulting from the test conditions. (auth)

10448 DESALINATION OF SEA WATER AND PRODUCTION OF ENERGY. Bidard, Rene (Compagnie Electro-Mecanique, Paris). Rev. Gen. Elec., 76: 1001-8(Aug. 1967). (In French).

The problem of desalination is reviewed from a general point of view and various procedures in use are examined. Some attention is devoted to thermal and stage-distillation techniques; the possible coupling of desalination and nuclear energy is discussed. Unfavorable features of such a combination include cost competitiveness, particularly if fossil fuel can be cheaply delivered and the site is far from industry. On the favorable side, nuclear power is more adapted to the concomitant generation of power and fresh water. In combination with a flash distillation technique, nuclear power provides more water per unit of power than other techniques. A combination use of a nuclear power source would allow improvement of nuclear power installations in relation to the uses of an extended electric network also in relation to the consumption of water. Further study is necessary to develop techniques. (BBB)

10449 RECYCLING PLUTONIUM IN NUCLEAR PLANTS. Fox, John C. (Battelle Northwest Labs., Richland, Wash.). Power, 111: 120-4(Dec. 1967).

The principal uses for plutonium are as recycle fuel in thermal reactors or stockpile for future fast breeders. Plutonium competes more effectively than uranium for thermal neutrons through its higher capture probability. Plutonium dioxide differs in physical properties from uranium dioxide. Plutonium is recoverable at any step of the fuel process. The economic feasibility of the use of plutonium as a fuel is discussed. (J.C.W.)

10450 PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE ON MAGNET TECHNOLOGY, OXFORD, ENGLAND, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967. 777p. 100s. (CONF-670705).

Separate abstracts were prepared for 76 of the 91 papers presented. Fifteen papers were previously included in NSA. For abstract numbers of these papers see CONF-670705 in a cumulative report number index. (B.G.D.)

For abstracts of individual papers see: 10451–10457, 10581, 10582, 10600–10603, 10649–10655, 11106, 11363–11379, 11412, 11413, 11448, 11512, 11772–11804, and 12103.

10451 MECHANICAL STRESS IN LARGE HIGH FIELD MAGNET COILS. Middleton, A. J.; Trowbridge, C. W. (Rutherford High Energy Lab., Chilton, Eng.). pp 140-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Three methods are considered for evaluation of stresses. The first method uses classical homogeneous theory, taking into account the axial stress. The magnet for the proposed High Field Bubble Chamber is given as an example. The coils for this are in the form of a stack of spirally wound pancakes, the turns being separated by circumferentially discontinuous spacers. The second method considers the non-homogeneity of such a coil. The third method introduces the effect of friction in a loosely wound spiral coil, and demonstrates how the limiting case of infinite friction tends toward floating thin shell theory. In all cases the material is assumed to remain within the elastic limit. (auth) (UK)

10452 EXPERIMENTAL STUDIES, DESIGN, AND CONSTRUCTION OF BITTER SOLENOIDS. Boissier, R. (Societe Alsthom, Belfort, France); Brichant, F.; Goyer, J.; Fournier, J.; Ricque, R.; Feron, J. L.; Pauthenet, R.; Picoche, J. C. pp 157-64 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The results of research on the construction and operation of Bitter solenoids are described, together with experimental work using such solenoids. (auth) (UK)

10453 A 300 TURN PULSED MAGNET: EDGEWOUND FROM CONTINUOUS STRIP. Hoare, F. J.; Whittle, H. R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 165-70 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

A number of methods have been used to wind pulsed magnets suitable for generating field intensities greater than 200 kG. Reported experience shows that wire-wound coils have a limited life—apparently because of the inherent difficulty of preventing relative movement between elements of the winding, which leads to insulation failure. Spirally wound coils made from wide thin foils are also unreliable for the same reasons. From the reliability point of view there appears to be no real alternative to the helically wound ("Bitter" type) coil. It is easy to make small helical coils on a lathe using screw thread turning techniques, but as the bore of the coil and the number of turns increase so the difficulties multiply. The depth of cut increases with the bore so as to retain a reasonable ratio (α) of outside to inside radius. Also the length of billet increases with the number of turns until it is difficult to maintain a stable cut owing to the springiness of the work-piece. In order to make a 300 turn coil (to match an existing power supply) the authors edge wound a continuous copper strip and machined its active length, rather than resorting to the normal overlapped disc construction. Using this technique it has been possible to make a 300 turn coil 7.5 cm bore × 13.5 OD (i.e. $\alpha = 1.8$). The coil is fully insulated with glass-cloth and impregnated with epoxy resin and is suitable for connection to a 20 kV capacitor. (auth) (UK)

10454 SOLENOIDS PRECOOLED BY LIQUID NITROGEN FOR PULSED MAGNETIC FIELD. Krempasky, L. (Electrotechnical Inst., Bratislava). pp 171-5 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Solenoids with uniform current density, precooled by liquid nitrogen were investigated. At the moment of switching on the solenoid to a constant voltage supply, the current will rise from zero at a rate controlled by the initial value of the circuit time constant τ_0. As the current increases, the energy dissipated in the coil will cause a rise in temperature, with corresponding rise in resistance of the coil. As the resistance continues to rise, the current will not reach a steady value I_0, but will reach a maximum value $I_m < I_0$ at the time t_m and then begin to fall away. A relatively simple form of the equation $i = f(t)$ is derived, bearing in mind some approximations. The equation derived contains only two parameters, determining t_m and the ratio I_m/I_0 uniquely. A method is described enabling design of the optimal solenoid (i.e. solenoid giving maximal field) for a given power supply and inside diameter of the solenoid. (auth) (UK)

10455 INSULATION OF WINDINGS IN ELECTRO-MAGNETS. Carlier, J.; Goyer, J. (Societe Alsthom, Paris). pp 330-40 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The methods of insulation set up for turbo-generators, large hydraulic machines, and large synchronous and induction machines are being put into practice for electromagnets. The process employed, known under trade-mark "ISOTENAX", consists of continuous taping with a glass and samica tape, pre-impregnated with epoxy resin. For magnet windings, the process is employed for turn insulation, and ground insulation of the pancakes. Very satisfactory insulation has been obtained, but some disadvantages are mentioned. (auth) (UK)

10456 RESIN ENCAPSULATION OF MAGNET COILS. Sheldon, R.; Stapleton, G. (Rutherford High Energy Lab., Chilton, Eng.). pp 352-62 of Proceedings of the Second International

Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The application of resin glass composite to the fabrication of nuclear physics magnets is described. The Rutherford Laboratory is concerned with the use of resin glass composites with particular emphasis on their application to nuclear environments. This interest has stemmed from the decision to manufacture vacuum vessels from epoxy resin/glass fabric laminate, and considerable experience has been built up in manipulating and applying this material. The interest in the application of resin/glass composites to magnet coil encapsulation. The problems involved in the design and manufacture of resin impregnated nuclear physics magnet coils are outlined. (auth) (UK)

10457 AN AXIALLY-FED 100kG PULSED FIELD COIL. Harries, K.; Insinger, F. G.; James, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 742-8 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967. (CLM-P-144).
See CONF-670705.

A fractional-turn axially fed coil, 8 cm diameter by 8 cm long, is described. It is designed to give a peak magnetic field of 100 kG at a current of 1.25 mA, rising in 2.5 μsecs. The coil winding consists of ten parallel strips of 1.1 turns spirally wound on a slotted aluminium alloy flux excluder, which also withstands the magnetic forces. With such a coil the magnetic flux surfaces may in principle have any arbitrary shape, provided axial symmetry is maintained. (auth) (UK)

10458 IMPROVEMENTS IN OR RELATING TO THE REMOVAL OF SHEATHS FROM NUCLEAR FUEL ELEMENTS. Guneratne, Piyatilleke Perera; Robson, William Selwyn (to United Kingdom Atomic Energy Authority). British Patent 1,097,597. Jan. 3, 1968. Filed Nov. 3, 1964.

A method is described for removing the protective sheath from irradiated fuel elements. The sheath is expanded from the fuel member by passing a high frequency alternating current through the sheath to raise the temperature of the sheath in relation to the temperature of the fuel member. The increased temperature will soften the sheath so that it may be removed ultrasonically or by scrapers or shredders without previous scoring of the sheath. (F.S.)

10459 STUDY OF A NEON CYCLE CRYOGENIC PUMPING SYSTEM FOR A LOW-DENSITY PLASMA TUNNEL. Lafrance, Jean Claude. Toronto, Univ. of Toronto, 1966.
Thesis.

The development and testing of a large neon cycle cryogenic pump for use with a low density wind tunnel for both ionized and non-ionized flows is described. The development work necessary in the choice of the refrigerant cycle and the production of the required hardware is described in some detail. Once the cryogenic pump was in operation it was thoroughly tested both as a refrigerator system and as a pump. Experimental data on the thermodynamic properties of neon were obtained and found to be in excellent agreement with the available theoretical data. The refrigerator cycle was found to operate satisfactorily and as predicted. The pump itself was found to operate satisfactorily and as predicted over its entire designed range of operation. A pumping rate of 0.8 gr/sec N_2 was achieved while maintaining the test section pressure in the 1 to 4×10^{-3} torr region. (Disser. Abstr.)

10460 NUCLEAR REACTOR FUEL ELEMENTS. Ironside, Alexander Mepher; Robertson, James Martin (to United Kingdom Atomic Energy Authority). British Patent 1,097,972. Jan. 3, 1968. Filed Sept. 30, 1964.

A reactor fuel element is described which consists of at least two spaced concentric tubes each of which has at least one curved plate of clad fuel with adjacent edges joined together and the joints of one tube being staggered relative to the joints of the other. The element has at least one chamfered edge. (F.S.)

10461 IRRADIATION APPARATUS. Kerjean, Joel. (to Commissariat a l'Energie Atomique). British Patent 1,094,423. Dec. 13, 1967. Priority date July 30, 1965, France.

The design of an irradiation apparatus for irradiation of samples with a high gamma flux is presented. This apparatus achieves high-flux irradiation due to the design of the source channels which generate a hyperboloid of one surface whose axis is the same as the irradiation chamber. (W.H.K.)

10462 IMPROVEMENTS IN APPARATUS FOR AND METHODS OF OPENING TUBULAR MEMBERS. Humbert, Jacques; Pelardy, Raymond (to Commissariat a l'Energie Atomique). British Patent 1,096,745. Dec. 29, 1967. Priority date Mar. 2, 1965, France.

An apparatus for opening a tubular member consists of a slightly concave mortise chisel for introduction into the tubular member and supporting a cutting blade perpendicular to its edge. A rearwardly enlarged separating deflector is provided that is in line with this chisel. The narrowest part of the deflector corresponds to the surface in contact with the chisel and has a crescent-shaped cross section. Thus the tubular member is split radially at the same time it is removed from its contents. The apparatus is particularly adapted for decanning treated nuclear reactor fuel rods intended to undergo further examination or for decanning irradiated cartridges for reprocessing. (B.L.M.)

10463 DEVICE FOR THE MECHANICAL DECANNING OF ROD-TYPE ELEMENTS IRRADIATED IN A NUCLEAR REACTOR. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,096,805. Dec. 29, 1967. Priority date Oct. 9, 1965, Germany.

A device is described for the mechanical decanning of rod-type fuel or fertile elements irradiated in a nuclear reactor in which the element is advanced by transport rollers for the axial feed and in which cutting tools are provided for the execution of longitudinal cuts in the element can. The device is characterized by a hollow drill rotatable around its longitudinal axis. The outside diameter of the drill is equal to the inside diameter of the can of the element to be processed. (B.L.M.)

10464 METHOD AND APPARATUS FOR LOADING AND UNLOADING A FILTER FOR RADIOACTIVE GASES. Lucas, Jean Claude (to Saint-Gobain Nucleaire). U. S. Patent 3,354,616. Nov. 20, 1964.

A method of removing a filter element for radioactive gases from a filter casing through a loading opening in a wall of the filter casing consists of fixing the mouth portion of a sack of plastic sheet material to and about the opening to seal the opening. The filter element is then withdrawn through the opening and into the sack. After this, the sack is sealed between the portion of the sack containing the element and the mouth of the sack. The sealed area is severed to leave a portion of the sack sealing the element within the sack and a second portion of the sealed area sealing the loading opening of the casing. (TSS) (Offic. Gaz.)

10465 ADJUSTING DEVICE FOR REMOTE CONTROL MANIPULATORS. Kirby, Roy K.; Wicker, Charles D. (to United States Atomic Energy Commission). U. S. Patent 3,365,978. Jan. 30, 1968.

A device for adjustably selecting a rest position of the slave unit in a tape driven remote control manipulator is described. A shaft mounted roller cage houses a pair of rollers for engaging the tape drive of the manipulator. Rotation of the roller cage effectively changes the distance traveled by the drive tape, thereby causing it to change the rest position of the slave unit. Ratchet means secure the shaft and roller cage in any desired angular position so as to fix the rest position of the slave unit. (AEC)

10466 MEANS FOR CONTROLLING THE FLOW OF FLUID. French, Peter Raymond Joseph; Robinson, John Albert (to Nuclear Power Plant Co., Ltd. AEI–John Thompson Nuclear Energy Co., Ltd.). British Patent 1,099,931. Jan. 17, 1968. Filed May 22, 1964.

A method is described for controlling the flow of a fluid through a duct by reducing the force due to the gas pressure on the fluid. A convergent passage located external to the ducts defines the upstream and downstream sides of the fluid and has a cross section which is small in relation to the cross section of the duct. The convergent passage reduces the fluid pressure. (F.S.)

10467 ELECTRICAL CONDUCTOR CONTAINING AN IONIZABLE GAS AND RADIOACTIVE MATERIAL TO IONIZE THE GAS. Babigan, Raymond U. S. Patent 3,361,866. Apr. 9, 1965.

An electric conductor comprising a metallic housing, a metallic wire spaced within the housing is described. A metallic means connects the wire and housing in an electrical conducting relationship. An ionizable gas is contained in the space between the housing and wire. Radioactive means are associated with the conductor for ionizing the gas. (Offic. Gaz.)

10468 BALANCED ARTICULATED MANIPULATOR. Haaker, Lester W. (to Commissariat a l'Energie Atomique). British Patent 1,097,800. Jan. 3, 1968. Priority date Nov. 12, 1965, United States.

A remote control master-slave manipulator with articulated arms is described. A system designed for maintaining the slave arm in balance through its movement regardless of the position or displacement of the master arm includes two differential methods which together add opposing and auxiliary motions to maintain the slave arm in near-perfect balance at all times in normal use regardless of its position relative to the master arm. (F.S.)

10469 IMPROVEMENTS IN OR RELATING TO ARRANGEMENTS FOR CLOSING PENETRATIONS IN THE WALLS OF PRESSURE CONTAINING STRUCTURES. Lockett, George Edward; Coast, Geoffrey; Coudray, Michel; Vitry, Pierre; Torielli, Enea (to United Kingdom Atomic Energy Authority). British Patent 1,098,281. Jan. 10, 1968. Filed Apr. 7, 1964.

Arrangements for closing penetrations in the walls of structures containing fluids at pressures higher than atmospheric such as reactor pressure vessels are described. A remote closure device is used. It consists of two members, a device for mounting the members one behind the other forming inner and outer members with respect to the vessel. The outer member and its mounting form a sealed closure against the pressure difference contained by the vessel. The inner member and its mounting resist displacement by pressure excursions in the vessel. (F.S.)

10470 IMPROVEMENTS IN OR RELATING TO CONTAINERS. Pugh, Stanley Frederick; Craston, John Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,098,261. Jan. 10, 1968. Filed Apr. 13, 1965.

Improvements in the design of containers subject to internal pressure such as the sheath of nuclear fuel elements pressurized by the accumulation of gases formed by the fission process are described. The container is formed with walls with anticlastic surfaces. Such surfaces have opposite curvatures at any given point on the surface. The surface is curved convexly along a longitudinal plane and concavely along the perpendicular section. (F.S.)

10471 NUCLEAR FUEL ASSEMBLY WITH THERMAL BAFFLE. (to United States Atomic Energy Commission). British Patent 1,099,838. Jan. 17, 1968. Priority date Dec. 24, 1964, United States.

An improved fuel assembly is described which is provided with an integral thermal barrier between the fuel-primary coolant region and moderator region in a pressure tube-type reactor in which the fuel assemblies are located within U shaped pressure tubes suspended into the moderator. The improved fuel assembly contains a flow baffle of tubular shape with a plurality of flat sides, a hollow cylindrical thermal baffle surrounds the flow baffle. Both baffles are attached to upper and lower guide rings. A grid member extends across the coolant flow path and is attached to one of the guide rings. The fuel rods are positioned by the grid ring and are held together by the flow baffle. Elongated baffle strips are provided between the sides of the flow baffle and the thermal baffle to reduce convection currents. (F.S.)

10472 FORCE-REFLECTED HANDLING DEVICE. Ejiri, M. (to Hitachi Ltd.). Japanese Patent 1966-12764. July 20, 1966. Filed Nov. 16, 1963.

In the conventional handling devices such as cranes, power shovels, and power manipulators for radioisotope handling, the operator observes the position of an object with the eye, and then handles the object by actuating switches on the master side, thereby moving the members on the slave side. But if the slave side is far away from the master side, it is difficult for the operator to grasp the condition on the slave side when the accurate handling is required. In the force-reflected handling device described, the force acting on the slave side is reflected onto the manipulator handle on the master side, as the handling proceeds. This gives a sense of force to the operator, enabling accurate and complicated handling of an object. The device consists of a hand-operated handle (of the pistol type, for example), which returns to the original position when the operator withdraws his hand from the handle; a device, which changes the handling speed (on the slave side) stepwise or continuously as the handle position is moved away from a certain range of positions where the handling speed is zero; and a device, which detects the force acting on the slave side and gives the sense of force to the hand of the operator. (NSA of Japan)

10473 DEVICE FOR FILTERING RADIOACTIVE GASEOUS WASTES. Sugimoto, Senichi (to Japan Atomic Energy Res. Inst.). Japanese Patent 1966-13558. July 29, 1966. Filed Jan. 24, 1962.

Radioactive gaseous wastes, before discharging to the atmosphere, must be cleaned of harmful solid particles. The device described can be applied even for radioactive gaseous wastes with high solid content; it can be used either as the preliminary filter by itself or in combination with an AEC filter, or as the complete filter by arranging two of the device in series. The advantages of the device are simple renewal of filter material by winding; tight holding of filter material; high filtering efficiency using suitable filter materials; and a reduced cost of filter material by using a roll of filter sheet without cutting into pieces. Two conical bodies are joined together, with the bottom of one cone to the bottom of the other cone forming the filtering chamber. Between the bottomsides of the two cones is inserted a sheet of filter cloth or asbestos; both ends of the sheet are wound around the rollers, which are located outside the chamber. When operated, the upper and lower conical bodies are tightened together by means of bolts and nuts. (NSA of Japan)

10474 METHOD OF PRODUCING TUBE PLATES, MORE PARTICULARLY FOR NUCLEAR REACTOR PRESSURE VESSELS. (to Commissariat a l'Energie Atomique). British Patent 1,098,590. Jan. 10, 1968. Priority date Apr. 21, 1965, France.

A method for fabricating tube plates for use in nuclear reactor pressure vessels is described. The tube plate is formed by welding the shoulders of cylindrical tubes to the shoulders of adjacent tubes. Further machining is completed after welding. (F.S.)

10475 COMBINED INSULATING AND CRYOGEN CIRCULATING MEANS FOR A SUPERCONDUCTIVE SOLENOID. Brechna, H. (to United States Atomic Energy Commission). U. S. Patent 3,363,207. Jan. 9, 1968.

This patent relates to a superconducting solenoid in which the coil layers are separated with a sandwich comprised of an oxidized metallic screen between sheets of porous electrical insulation such as fiberglass cloth. The cloth is provided to electrically insulate adjacent coil layers, while the screen is provided as a short circuit for dissipation of secondary currents. The porosity of the cloth and the vertical and horizontal passages between interstices of the screen permit a liquid cryogen to be circulated freely in both horizontal and vertical directions between turns and layers of the coils for cooling thereof. (AEC)

10476 CHARGED-PARTICLE IRRADIATION DEVICE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1967-2638. Feb. 16, 1967. Filed Jan. 23, 1965.

In the charged-particle irradiation device proposed, in which a plurality of unit-length filaments are aligned to give a radiation beam of a linear cross-section, only the required number of filaments are operated, thereby giving an economy operation of the device as a whole. The terminal of each unit-length filament is connected separately to the common high-voltage source; and a switch is installed to each terminal. Each filament can thus be operated separately from others. (NSA of Japan)

10477 DEVICE FOR INDICATING THE IRRADIATION FIELD. Furuya, Nobumichi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-4028. Mar. 7, 1967. Filed Nov. 27, 1963.

By the method proposed, the following advantages are obtainable: increased contact radiation therapy, compacting of the irradiation apparatus, and indication of the clearer irradiation field. It includes a container of lead (or the like), with an irradiation aperture, containing a radiation source; the iris, located in front of the container, which determines the irradiation field; a convex mirror, located between the chamber and the iris, with the concave side facing the iris, through which the radiation penetrates well; a light reflector, located at the focus of light from the mirror, above the iris; and a plurality of pairs of lenses and light sources, for supplying the necessary light to the reflector. (NSA of Japan)

10478 IMPROVEMENTS IN BUCKET ELEVATOR WHEELS AND THE CONTROL THEREOF. Theuriax, Gabriel (to Commissariat a l'Energie Atomique). British Patent 1,098,584. Jan. 10, 1968. Priority date Sept. 15, 1964, France.

A bucket elevator wheel is described which will provide a constant supply of liquid or solid particles at a very low rate of flow. The rate of flow is too low to be obtained by means of proportioning pumps. The device is particularly useful in processing radioactive liquids. (F.S.)

10479 FUEL ELEMENT FOR NUCLEAR REACTOR. Schmitt, Andre; Storrer, Freddy (to Commissariat a l'Energie Atomique). British Patent 1,099,298. Jan. 17, 1968. Priority date Dec. 7, 1965, France.

A fuel element for use in a very low-power nuclear reactor or critical assembly is described. The reactor or assembly has a horizontal fuel element suspension plate and a fuel element centering grid movable between an upper position in which recesses engage the fuel elements and a lower position in which it is disengaged from the fuel elements. Each fuel element has a body occupied by fuel material, an upper portion with a method for connecting it to the suspension plate and a lower portion formed by a spigot adapted to fit into a recess of the mobile centering grid. The spigot is separate from the body but connected by a membrane adapted to break under stress in the upper direction. The rupturing member is a washer locked in the body with lugs which project inside the body and form an abutment resisting ascent of the spigot into the recess in the body. (F.S.)

10480 METHOD OF AND APPARATUS FOR CUTTING GROOVES IN A WORKPIECE. Portal, Pierre; Rouchaud, Jacques (to Commissariat a l'Energie Atomique). British Patent 1,098,761. Jan. 10, 1968. Filed Apr. 22, 1966.

A method and equipment are described for cutting a series of grooves in a workpiece such as the flanges or fins spaced over the periphery of sheaths for fuel elements for nuclear reactors. Machine tools mounted on a number of parallel spindles cut a series of rectilinear grooves in each of the faces of a polygonal section to form flanges or fins. A linear divider is used to move the workpiece for new cutting operations in another face. The spindles are mounted on a carriage which is mounted on a vertical column and is controlled by a hydraulic system. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 10427, 10432, 10466, and 10942.

10481 (ALO–3634–6) VACUUM FOIL-TYPE THERMAL INSULATION FOR RADIOISOTOPE POWER SYSTEMS. Phase I, Final Report, February 8, 1966–August 8, 1967. Dunlay, J. B.; Fronduto, J.; Paquin, M. L.; Poirier, V. L.; Van Someren, L. (Thermo Electron Corp., Waltham, Mass.). Contract AT(30-1)-3634. 250p. Dep. CFSTI.

Compatibility tests identified insulation material combinations acceptable for operation at 1700 and 1900°C. The tungsten-thoria and tungsten 25% rhenium alloy-thoria combinations were satisfactory at 1700°C for the entire 2000 hour test period, and at 1900°C for 500 hours. Heat flux measurements were made on planar and cylindrical test samples. The molybdenum-thoria combination outperformed other insulation samples. Insulation performance was measured as a function of applied compressive loads and the accumulated total hours of operation. An analytical and experimental effort evaluated insulation corner designs. The heat loss per unit length of edge was measured as a function of source temperature for three corner configurations. The thermal losses associated with two types of structural support insulation were measured. Preliminary designs were developed for a static structure test assembly and an insulation demonstration system. (auth)

10482 (EUR–3643) LUPO: A PROGRAM FOR PREDICTION OF STEADY-STATE TEMPERATURE, FLOW RATE, AND PRESSURE DROPS IN A CLOSED PRESSURIZED WATER LOOP WITH OR WITHOUT BOILING. Gaggero, G.; Panella, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center. European Atomic Energy Community, Ispra (Italy). European Scientific Data Processing Center. Politecnico di Torino (Italy)). Aug. 29, 1967. 109p. Dep.

A method is described for predicting steady-state bulk fluid temperature, void fraction, pressure drops and mass flow rate in a closed pressurized water loop, operating at forced or natural circulation. The model treats the one-dimensional transfer of mass, momentum, and energy throughout the whole liquid, subcooled boiling, and bulk boiling regions of the coolant using semi-empirical heat transfer and pressure drop correlations developed by other investigators. A representation of subcooled boiling is used. Variations in heat transfer and hydraulic characteristics of the coolant due to changes in temperature and state are handled by continuously calculating local values of thermodynamic and physical properties (specific heat, density, quality, viscosity, thermal conductivity, etc.). The method has been programmed for the IBM 7090 and IBM 360/65 computers by using FORTRAN IV language. The code, LUPO, is described along with the numerical treatment and calculation procedure. A comparison with experimental data is presented. (auth)

10483 (IN–1110) RADIATIVE AND CONVECTIVE HEAT TRANSFER WITHIN VERTICAL ANNULAR SPACES OPEN AT THE ENDS. Petrie, J. C.; Dickey, B. R.; Legler, B. M. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 58p. Dep. CFSTI.

Convective and radiative heat transfer within a vertical cylindrical annulus open at the ends has been investigated. Data for natural convective heat transfer from the inner cylinder are compared with data for natural convective heat transfer from isolated surfaces. The rate of heat transfer across the annulus by conduction and convection is calculated by means of a pseudoeffective thermal conductivity, the resulting values being up to 1.8 times the effective conductivity for a completely enclosed annulus. Radiative heat transfer from the inner to the outer cylinder was calculated using a digital computer program based on the absorption factor method of Gebhart. (auth)

10484 (ORNL–4159) DEVELOPMENT OF A 500-kw NaK-TO-AIR RADIATOR. MacPherson, R. E.; Gray, R. J. (compss.) (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 220p. Dep. CFSTI.

An extensive program of development testing and performance evaluation was carried out on a 500-kW, high-conductivity fin, multitube, and plate-fin radiator for heat transfer from NaK to air. This radiator was a prototype of the heat dump for the Aircraft Reactor Test and allowed fabrication problems and reliability of an aircraft-oriented design to be investigated. Eighteen units of the same basic design were tested using NaK at 1200 to 1600°F. These radiators were obtained from five sources and tested in four test stands operating concurrently during a two-year period. Modification of the original radiator design was required to provide greater freedom for differential thermal expansion. Thermal stresses were imposed on the tube-fin matrix during programmed thermal cycling operations and by thermal shocks during startup and occasional emergency shutdowns. Extensive postoperational metallurgical examinations revealed problem areas and suggested design modifications. Heat transfer and air pressure drop were measured on all units, and the problem of NaK-side pressure drop buildup due to temperature gradient mass transfer of nickel from the hot portions of the all-Inconel test system was studied. The effect of Na_2O concentration in the NaK on radiator pressure drop was investigated and the necessary equipment and operating techniques were developed to allow control of this variable. The prototype radiator possessed the performance capabilities and mechanical integrity to meet the design requirements of the Aircraft Reactor Test. (auth)

10485 (SAN–677–15) INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS. Quarterly Report, April 1–June 30, 1967. Poppendiek, H. F.; Feigenbutz, L. V.; Greene, N. D.; Sabin, C. M. (Geoscience Ltd., Solana Beach, Calif. Geoscience Ltd., La Jolla, Calif.). Contract AT(04-3)-677. 69p. Dep. CFSTI.

Research activities on liquid metal boiler conditioning studies applicable to Rankine cycle systems are described. A recapitulation is made of the mathematical droplet vaporization models that have been derived to help define the variations in boiling heat transfer for conditioned and de-conditioned boilers. Specifically, the parameters surface roughness, surface tension, liquid and boiler wall impurities, wall-saturation temperature differences and the physical properties are considered. A summary of mercury droplet vaporization lifetime measurements as a function of wall-saturation temperature difference and surface roughness for Croloy 9M, Haynes 25, niobium, nickel and copper surfaces is presented. Forced, linear flow, boiling mercury conductances as functions of vapor quality and flow rate are presented for Croloy 9M, Haynes 25, and niobium. Synthesis and interpretation of the droplet vaporization and forced flow boiling measurements are presented in the light of the mathematical models and the physical and chemical parameters previously noted. (auth)

10486 (SAN–677–19) INVESTIGATION OF FUNDAMENTAL MECHANISMS AND PARAMETERS THAT INFLUENCE STEADY STATE AND TRANSIENT PERFORMANCE OF RANKINE CYCLE LIQUID METAL SYSTEMS. Quarterly Report, July 1–September 30, 1967. Poppendiek, H. F.; Greene, N. D.; Sabin, C. M.; Goddard, W. B. (Geoscience Ltd., Solana Beach, Calif.). Contract AT(04-3)-677. 28p. (GLR–58). Dep. CFSTI.

Research activities on phase distributions in forced flow boiling applicable to Rankine cycle systems are described. A Freon 11 boiling system was modified and used to evaluate the problems in forced flow phase distribution photography. Pressures, temperatures and flow velocities were measured with this system. Preliminary photographs of rapidly moving mercury droplets were obtained. Two analytical studies relating to phase distribution in a boiler tube were made. One analysis consisted of the prediction of the velocities of liquid drops located at the boiler tube wall under both direct contact and film boiling conditions; radial variations of the vapor velocities in the two phase system were also included. Additional calculations were made for the dynamics of oscillating drops; information on the oscillation period and average heat transfer is presented. (auth)

10487 (SU–326–P–13–2) A STUDY OF RADIATION-INDUCED NUCLEATION OF BUBBLES IN SUPERHEATED WATER. Annual Progress Report for the Period March 15, 1967 to date. Deitrich, L. W. (Stanford Univ., Calif. Dept. of Mechanical Engineering). Dec. 15, 1967. 20p. Dep. CFSTI.

A bubble chamber system with its pressure cycling circuit and various controls was assembled to study radiation-induced nucleation of bubbles in superheated water. The chamber was covered with insulation and partly surrounded by a blast shield. Silicone fluid was substituted for Hg as the fluid which isolates the pressurizing N gas from the water in the bubble chamber. The fission

fragment α source and a stainless steel spatula coated with U_3O_8 (93% U-235) to a thickness of 1.5 mg/cm^2 over an area of ~4 cm^2 were prepared. Work on the construction of the system, bubble chamber, expansion system, optical system, instrumentation, and the radiation source is described. (F.S.)

10488 (TID-24126) THE MEASUREMENT, INTERPRETATION AND USE OF UNSTEADY MOMENTUM FLUXES IN TWO-PHASE FLOW. Report No. 70318-50. Yih, Tien Sieh; Griffith, Peter (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Aug. 1967. Contract AT(30-1)-3496. 35p. Dep. CFSTI.

The steady and unsteady components of the momentum flux in a two-phase flow were measured at the exit of a vertical pipe by means of an impulse technique using a turning tee and beam. Different electrical filters have been tried in the recording circuit for eliminating the signals around the natural frequency of the beam system. A special filter set has been designed to approximate the inverse of the transfer function of the beam system. Thus the signals recorded after passing through the beam-filter combination can be considered as the excitation times a constant. Two different analog methods have been used to analyze the random signals for obtaining some statistical quantities such as the predominant frequency and the rms value of the unsteady momentum flux. These quantities are useful in some applications involving two-phase flow. In the preliminary measurements of the unsteady momentum flux for the adiabatic up flow of an air-water mixture in a $\frac{5}{8}$ inch pipe, the greatest unsteadiness of momentum flux appeared in the quality range of one per cent to six per cent. Above ten per cent quality no appreciable fluctuation has been detected. In an example problem, using the preliminary results, the effect of the unsteady momentum flux on a fuel rod has been studied. The amplitude of the vibrations resulting from the two-phase excitation has been found. In addition it has also been found that there is a possibility of unstable vibrations due to a nonlinear restoring force on the fuel element. This nonlinearity is due to the unsteady component of the momentum flux in the flow past the rod. (auth)

10489 (UCRL-50352) SOME TIME-DEPENDENT SOLUTIONS FOR GAS-DYNAMIC FLOWS WITH MASS ADDITION AND FRICTION. Crowley, Barbara K. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 16, 1967. Contract W-7405-eng-48. 15p. Dep. CFSTI.

Time-dependent solutions of the one-dimensional conservation equations are obtained for gas flows with mass addition and friction. To analytically integrate the conservation equations, the flows are considered uniform, without pressure or velocity gradients. Since $\partial U/\partial x = (1/V)(dV/dt)$ for a given element in one dimension, the absence of a velocity gradient implies a constant-volume flow. The solutions indicate that, with either friction or mass addition, both the velocity of flows and the change in velocity compared to the original velocity decrease inversely with time. The velocity thus approaches a nearly constant value, or apparent terminal velocity. When both friction and mass addition are present, velocity decreases logarithmically with respect to time, and the apparent terminal velocity is approached sooner. It is hoped that if their time-dependent effects on constant-volume flows are illustrated, the presence of mass addition and friction in more complex flows may be better appreciated. (auth)

10490 (WAPD-TM-386) SOME EXPERIMENTAL TECHNIQUES USED IN REACTOR HEAT TRANSFER AND FLUID FLOW RESEARCH. Green, S. J. (ed.) (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT(11-1)-Gen-14. 223p. Dep. CFSTI.

Experimental techniques used in obtaining heat transfer and fluid flow data are described. The principal objective of the experiments was to obtain information that describes rather than explains the particular phenomenon being investigated. Thus, a description of studies that are macroscopic rather than microscopic in nature are provided. (auth)

10491 IMPROVED HEAT-TRANSFER PERFORMANCE WITH BOUNDARY-LAYER TURBULENCE PROMOTERS. Sutherland, W. A. (General Electric Co., San Jose, Calif.). Int. J. Heat Mass Transfer, 10: 1589-99(Nov. 1967).

Heat transfer and friction measurements were made in a parallel rod array with air flowing past electrically heated rods. The measurements were made over a range of Reynolds number, with various turbulence promoter heights and separations, and at rod-spacing-to-diameter ratios of 1.15 and 1.25. The experimental apparatus and procedure are described. The performance of boundary-layer promoters was established, and the results are directly applicable to thermal performance prediction and optimization in rod bundles. (UK)

10492 ANALYTICAL INVESTIGATION OF THE EFFECT OF VARIABLE WALL HEAT FLUX ON TURBULENT LIQUID-METAL HEAT TRANSFER COEFFICIENTS IN REACTOR COOLANT CHANNELS. Johannsen, Klaus (Massachusetts Inst. of Tech., Cambridge). Atomkernenergie, 13: 21-4(1968).

The forced-convection heat transfer to a liquid metal flowing turbulently between parallel plates with a variable wall heat flux in flow direction was investigated using Poppendiek's simplified model. Sample calculations for a sinusoidally varying heat flux show the strong dependence of the heat transfer coefficient on channel length. In some cases, this effect could pose problems for small liquid metal-cooled reactor cores of high power density (auth)

10493 AN ANALYSIS OF HEAT-TRANSFER DATA FOR SPRAY-COOLED RODS. Lawson, C. G. Nucl. Safety, 9: 43-5(Jan.-Feb. 1968).

Heat-transfer data obtained in the Japanese SAFE program are analyzed to extract the convective heat-transfer coefficient and the radiation gray-body form factor times the emissivity coefficient from the hot test rods to 1-atm wet steam. It is concluded that the method of analysis results in an expression that has physical sense and may be extrapolated with reliability to determine steady-state transfer rates at high temperatures. (auth)

10494 FLOW OF COMPRESSIBLE TWO-PHASE MIXTURES THROUGH THROTTLING DEVICES. Chisholm, D. (National Engineering Lab., East Kilbride, Scotland). Chem. Process. Eng., 48: 73-8(Dec. 1967).

The mechanism of two-phase flow through nozzles and venturis is of growing interest to engineers working on general fluid-flow problems. Theoretical equations are developed for the flow of compressible gas/liquid mixtures through throttling devices, which are compared with data for flow through venturis, nozzles and sharp-edged orifices. (auth)

10495 IMPROVEMENTS IN AND RELATING TO HEAT TRANSFER SURFACES. (to General Electric Co.). British Patent 1,091,873. Nov. 22, 1967. Priority date Mar. 2, 1964, United States.

A method is described for preparing heat transfer surfaces to promote nucleate boiling of liquids adjacent to bubble nucleation sites on. A heat transfer wall has a source of heat located on one side and liquid boiling against the heat transfer surface of the other wall surface. The heat transfer surface contains a number of nucleation sites located in spaced relationship over the heat transfer surface. The surface of the nucleation sites need have a contact wetting angle with the liquid of at least 86°. (F.S.)

10496 IMPROVEMENTS RELATING TO THERMAL INSULATION. Hutchinson, William George; Cole, Leslie Charles (to United Kingdom Atomic Energy Authority). British Patent 1,098,485. Jan. 10, 1968. Filed Apr. 23, 1964.

Thermal insulation suitable for direct contact with liquids in a reactor is described. It consists of substantially parallel metal sheets which contain a number of closed shapes and are joined together by welds forming gas-filled fully sealed compartments. Since the interposed metal structure is a good source of heat conduction, it is kept to a minimum. (F.S.)

10497 ZHIDKIE METALLY. SBORNIK STATEI. (Liquid Metals. Collected Articles). Kirillov, P. L.; Subbotin, V. I.; Ushakov, P. A. (eds.). Moscow, Atomizdat, 1967. 444p.

The results of investigations made in the last year at the Physico-Energetics Institute of the State Bureau for Utilization of Atomic Energy are published. Theoretical and experimental studies on convective heat transfer in the flow of liquid metals in channels of different shape are reported. Heat transfer in round, annular, and square channels, heat transfer and hydrodynamics of complex channels, boiling and condensation of metals and work techniques with liquid metals are discussed. (J.S.R.)

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Refer also to abstracts 10435, 10436, 10439, 10442, 10467, 10929, 11103, and 11298.

10498 (AECD/HP-6) CALIBRATION OF A 500 CURIE ^{60}Co SOURCE. Rab Molla, M. A.; Abdullah, S. A.; Karim, F. (Atomic Energy Centre, Dacca (Pakistan). Health Physics Div.). Aug. 1967. 23p. Dep.

A 500 Curie ^{60}Co source was calibrated by Fricke (Ferrous-ferric sulfate) chemical dosimetry method. The source consists of a cylindrical pencil of metallic cobalt of 15.2 cm in active length and 0.95 cm in diameter and was housed in a 5-ft-thick concrete room. The dose rates at various distances from the

center of the source at five horizontal planes were determined experimentally. Appropriate equations were developed for the corresponding theoretical dose rates. All necessary corrections were made for both observed and calculated dose rates. Isodose curves were plotted using experimental values of dose rates. A short discussion on the scattering of γ-rays from the four walls, ceiling and the floor of the source room has also been made. In general, it was observed that the experimental dose rates at all distances except at 10 cm were higher than the corresponding calculated dose rates suggesting that there was some contribution due to scattering from floor, ceiling, and walls of the source room. (auth)

10499 (BNWL-529) NONDESTRUCTIVE TESTING OF ISOTOPE CONTAINMENT CAPSULES, SNAP-15A. Steffens, R. W.; Coffman, F. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1968. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

Ultrasonic nondestructive testing (NDT) has been shown capable of providing quality assurance data on final capsules as well as information feedback for process control purposes. Ultrasonic NDT was investigated for monitoring the weld quality of the peripheral end-cap weld on SNAP-15A isotope containment capsules. Weld parameters of interest were weld penetration, cavities at the weld root, and intergranular cracking near the boundary of the recast weld volume. The ultrasonic techniques were evaluated by comparing metallographic data with the respective ultrasonic data obtained on five inert-core weld samples. Results showed that weld penetration could be measured with an accuracy of ±5% of full penetration. The basis for a technique to detect cavities at the weld root was established, and an ability to detect intergranular cracking was indicated. The scope of this investigation did not include full development of the ultrasonic tests. In addition to a description of the ultrasonic test that was found to be advantageous for monitoring the SNAP-15A weld parameters, weld evaluation data obtained by metallographic analysis are included along with additional NDT development requirements for more complete weld evaluation, and the test results obtained on six fueled capsules. (auth)

10500 (DP-1096) DEVELOPMENT OF ^{60}Co CAPSULES FOR HEAT SOURCES. Ross, Charles P.; Angerman, Carl L.; King, Franklin D. R. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). June 1967. Contract AT(07-2)-1. 49p. Dep. CFSTI.

Radioactive cobalt containing 100 curies of ^{60}Co per gram of metal was encapsulated in Inconel 600 and Hastelloy C containers. Such capsules, producing up to 250 watts, have been tested successfully at 850°C for 100 hours in air. Preliminary tests indicate that TD Nickel (2% thoria-dispersed) and TD Nickel Chromium (78 nickel-20 chrome) are also promising materials for encapsulation. About 8 megacuries of ^{60}Co at activities up to 400 Ci/g will be available for heat source development and demonstrations by May 1967. Progress is reported in the areas of ^{60}Co production, fuel form properties, capsule design, capsule material properties, and capsule fabrication and testing. (auth)

10501 (EUR-3645) LES APPLICATIONS DES ISOTOPES RADIOACTIFS DANS LA FONDERIE. Rapport Final. (The Use of Radioisotopes in the Foundry. Final Report). Hencks, H.; Ney, E.; Wagner, H. (Acieries Reunies de Burbach-Eich-Dudelange S. A., Luxembourg). Sept. 18, 1967. 28p. (In French). Dep.

The use of radioisotopes in steel foundry operations is described. The research aims at nondestructive testing of steel castings having a mean thickness of about 100 mm in order to investigate problems of liquid metal convection, solidification, and contraction. The results will promote the manufacturing of homogeneous casting having a minimum of blowholes and porosities. Working procedures and preliminary experiments are described, the phenomena of convection and solidification in the case of the manufacturing of relatively thin walled slag ladles are discussed, and the mixing problems encountered in annular castings where two pouring ladles charged by two different furnaces are used are cited. (auth)

10502 (MND-3607-173) SNAP-19 RADIATION MEASUREMENTS REPORT. Rosenthal, H. B.; Owings, W. D.; Hrubovcak, J. M. (Martin-Marietta Corp., Baltimore, Md.). Nov. 1967. Contract AT(30-1)-3607. 99p. Dep. CFSTI.

The energy distribution and absolute magnitude of the neutron and gamma radiation emitted from SNAP 19 fuel capsules and assembled generator subsystems were determined. The data obtained were applied to determine the source of neutrons in the fuel capsule. Assembly and check out of instrumentation, spectrometer system evaluation against a known neutron source, measurement of SNAP 19 Sub-system S/N 4, providing analytical support for the measurements, and determination of the source of neutrons in the fuel capsule are described. (R.C.K.)

10503 (NAA-SR-12635) LARGE RADIOISOTOPE HEAT SOURCE CAPSULE PROGRAM. Topical Report No. 1. Capsule Materials Specifications. (Atomics International, Canoga Park, Calif.). Jan. 15, 1968. Contract AT(29-2)-2338. 112p. Dep. CFSTI.

The Large Radioisotope Heat Source Capsule (LRHSC) Program for the development of technology for high temperature (2000°F), long life heat sources (5 years or longer) which can be used in the space environment is described. The LRHSC program is specifically concerned with the development of a tantalum alloy fuel capsule. Data are presented on biaxial creep, impact and burial and include strain, compatibility and thermal maps. Material specifications which were prepared for all capsule materials are described. Because of the necessity for full characterization of materials and hardware these specifications were prepared to reflect both program needs and vendor capabilities. Material has in fact been obtained which meet these specifications. (auth)

10504 (ORNL-IIC-12) SPECIAL SOURCES OF INFORMATION ON ISOTOPES. McKinney, F. E.; Lafferty, R. H. Jr.; Baker, P. S. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 136p. (TID-4563(4th Rev.)). Dep. CFSTI.

A comprehensive guide to information and services related to isotopes is presented. Isotopes and their uses are described as background for those not familiar with the subject. The availability of references is given, as well as addresses of publishers. 831 separate sources of information including published literature, films, libraries, and information centers for all phases of isotope technology are listed. (L.C.L.)

10505 (PG-Report-824) ALTERNATIVE ECONOMICAL SOURCE OF ENRICHED URANIUM FUEL. Franklin, N. L. (United Kingdom Atomic Energy Authority, Risley (England). Production Group). 1968. 7p. Dep. CFSTI. UK.

It is postulated that the technical efficiency of plants designed for uranium enrichment will help to offset the effects of escalation in capital cost. In addition, attempts are being made to minimize operating costs, both in terms of direct labor and materials, and of indirect expenses by the maximum use of automatic control and programming of the plants. However, the capital charges which must be met impose a very serious burden in seeking a competitive position. The net effect is that costs of the order of 15% greater than the present US price are expected to be achieved when the second phase of the expansion of Capenhurst gets underway in the early 1970's. A 15% increase in the cost of separative work represents an increase of some 7 or 8% in the price of enriched uranium at the enrichment levels common in power reactors or some 0.08 mills/kwh in the generating cost. The costs of transport of enriched uranium, together with associated charges for stockholding etc., may be somewhat less for supply from a plant in Europe than for the case where transatlantic transport is involved. The margin in total cost to the reactor operator may therefore be less than the cost figures imply. (auth)

10506 (SAN-651-43) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 6, July 1, 1967-October 1, 1967. Adam, A. Warren (Sundstrand Aviation-Rockford, Ill.). Oct. 15, 1967. Contract AT(04-3)-651. 53p. Dep. CFSTI.

The working fluids biphenyl and the eutectic mixture of biphenyl and biphenyl ether were investigated for use in an organic rankine cycle power conversion system capable of long operation in a space environment. The program tasks are the investigation of the working fluid, bearings, condensate pumps, and boilers. A loop containing the eutectic has run for 1642 hrs. A loop containing biphenyl operated 1026 hrs when a leak occurred. Fluid which was lost was replaced and the loop restarted. Another loop containing biphenyl has run for 2200 hrs. Both biphenyl and the eutectic have shown excellent thermal stability. The bearing test rig was designed and is being fabricated. Bearings are being fabricated. All components of the pump test rig and test loop are on order or have been received. One pump to be tested has been delivered. All major hardware for the boiler test loop has been received and the assembly is over 50% complete. (F.S.)

10507 (SGAE-IB/IA-15/1967) FORTSCHRITTE IN DER ANWENDUNG VON LEITISOTOPENMETHODEN IN INDUSTRIE UND GEOPHYSIK. (Progress in the Application of Radioisotope Tracer Methods in Industry and Geophysics). Donhoffer, D. K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1967]. 12p. (In German). Dep.

On the basis of some selected works, a review is given of the progress made recently in the application of radioisotope tracer

methods. In addition to wear studies, geophysical uses, and the determination of waste distributions, the principal value lies in the use of radioactive tracers for investigation of the kinetic behavior of industrial production installations. Examples from the pipe industry and the chemical industry show the multiple uses of the tracer method. A new aspect for automatic process control is given by collaboration with modern computer methods. (tr-auth)

10508 A REVIEW OF THE USE OF RADIOISOTOPE TRACERS FOR EVALUATING PARAMETERS PERTAINING TO THE FLOW OF MATERIAL IN PLANT AND NATURAL SYSTEMS. Ljunggren, K. (Isotope Techniques Lab., Stockholm). Isotop. Radiat. Technol., 5: 3-24(Fall 1967).

The merits of radioactive isotopes as compared to other substances (salts, dyes) for use as tracers are described. For industrial plant investigations they are particularly useful because of the great sensitivity of detection which permits the use of such small amounts of tracer material that there is no possible interference with the process studied and the availability of gamma-emitting nuclides that make possible direct measurements of tracer concentrations from the outside of vessels and pipes carrying the tracers. The following uses of radioactive tracers in studies of flow of material, especially of fluids, are typical; in experiments designed to provide data for fundamental flow-theory formulation; for measuring flow parameters under well-defined conditions of flow, velocity, volumetric flow rate, dispersion in flow, etc.; for general examination of the characteristics of a flow system with respect to flow patterns, flow paths, etc.; for measuring the dilution caused by the dispersion of dissolved or suspended matter; and for the evaluation of process and process-equipment performance by arranging tracer tests, which provide residence-time distributions (from which mean residence times, dispersion indexes, blocked volume, hold-back, and similar characteristics can be extracted), information on mixing properties, channeling, recirculation, unintended connections, leakage, etc. The principles of the various methods and the practical procedures are discussed; when applicable, comparisons with alternative techniques are made, and reported figures on attainable precision and accuracy are cited. The theoretical aspects of the significance and evaluation of tracer investigations of material turnover are dealt with, with particular reference to concepts and models used in analyzing residence-time distributions. An attempt is made to discern general trends of development in radiotracer applications, such as the use of the obtained information for process control purposes. (auth)

10509 REPLACEMENT OF UNDERWATER BEARINGS IN A HIGH RADIATION FIELD. Huff, John B.; Lee, Joseph M. (Bureau of Commercial Fisheries Technological Lab., Gloucester, Mass.). Isotop. Radiat. Technol., 5: 25-8(Fall 1967).

A procedure and tools for replacing underwater bearings were developed and were used to replace worn ball bearings in the Marine Products Development Irradiator (MPDI) source-elevator mechanism with solid bearings. (auth)

10510 THE INDUSTRIAL USE OF LARGE RADIATION SOURCES. IV. ISOTOPE IRRADIATION PLANTS. Meyer-Jungnick, W.; Trageser, D. A.; Wiesner, L. Atomwirt., Atomtech., 12: 592-5(Dec. 1967). (In German).

A description is given of various suitable radionuclides and irradiated fuel elements and of their properties in relation to irradiation plants. Among the types of irradiation facilities using radiation sources, the first developed were the swimming pool sources which were conceived as an imitation of the swimming pool research reactors. Such plants were of course not used for industrial irradiation processes but only for research purposes. Small laboratory irradiation plants using a lead casing as shielding for the gamma radiation were developed in parallel with the swimming pool installations but these too were not suitable for technical process development work. Further development led to irradiation facilities in which the radiation sources could be moved back and forth between a storage position and an irradiation position. A further step is the development of flexible room irradiation plants in which the individual parts of the aggregate irradiation source are neither solidly connected to each other nor to a transport mechanism. The movement of the irradiation aggregate is brought about pneumatically or even by electromagnetic means. The degree of flexibility available in this way permits the optimization of the radiation field and the best possible utilization of radioactive materials of different half-lives which are introduced into the plant at the same time. The irradiation costs of plants using ^{60}Co and ^{137}Cs are described assuming usual conditions. (R.C.K.)

10511 EXPERIENCES AND KNOWLEDGE IN STUDIES ON THE MOVEMENT OF SAND IN COASTAL WATERS WITH RADIOISOTOPES. Schulz, Heinz (Bundesanstalt fuer Wasserbau Aussenstelle Kueste, Hamburg). Wasserwirtschaft, 57: 301-7 (Aug. 1967). (In German).

Movement and shifting of sand in coastal waters were studied by means of sand labeled with ^{46}Sc or ^{51}Cr. Studies are reported for areas at the mouth of the Weser River and the Jade River. Technical procedures, equipment, results, effects of flow conditions, measurement profiles, and plots of results are detailed and evaluated. The results and findings have proven to be valuable for knowledge and maintenance of navigation and commercial enterprises in the areas of the studies. (BBB)

10512 NEUTRON-IRRADIATION OF LUBRICANT ADDITIVES AND THEIR APPLICATION AS A TRACER. Iwasaki, Masao (Showa Oil Co., Ltd., Kanagawa, Japan); Yamaki, Naoomi. Junkatsu, 12: 207-12(1967). (In Japanese).

The preparation of radioactive lubricant additives by irradiation in a nuclear reactor is described. To investigate the possible decomposition of the additives during irradiation, 3 additives were heated at 150°C, the approximate temperature in the reactor. Changes in ir spectra and decreases in weight showed that dibenzyl disulfide (DBDS) and tricresyl phosphate (TCP) were not changed but Zn ethylhexyl dithiophosphate (ZEHDTP) was decomposed. Three additives were activated by neutron irradiation in a reactor. From the results even ZEHDTP was considered suitable for activation. After this preliminary feasibility study, the 3 additives were irradiated under a neutron flux of 2×10^{12} n/cm^2 sec for 107 hr. DBDS was used as a tracer since it was easily purified by recrystallization. TCP could not be purified chromatographically and the degree of degradation could not be determined. ZEHDTP had decomposed and could not be used. It was evident that additive changes observed in this irradiation were probably enhanced by the more severe conditions than those in the preliminary irradiation. Using DBDS-^{35}S as a tracer, the thickness of surface coating formed on a copper surface in 0.1 to 0.5% liquid paraffin solution at 80 to 210°C was measured. The thickness of the surface coating increased with longer immersion time, higher solution temperature, or higher additive concentration. The temperature at which a film began to be detected was higher at lower additive concentrations. Identification by x-ray diffraction and elemental analysis indicated that the surface coating consisted of Cu_2S. Some additives were multilabeled by neutron irradiation. In some cases, the nuclides can be distinguished by the difference of the penetrating power of radiation. The multilabeled additives can be used for tracing 2 or more elements simultaneously. (BBB)

10513 FISSION-FRAGMENT AUTORADIOGRAPHIC TECHNIQUE FOR DETECTING ^{244}Cm. Mosley, W. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl., 4: 42-6(Jan. 1968).

A fission-fragment autoradiographic technique has been applied to the detection of ^{244}Cm in solids. Fission-fragment tracks are registered in glass and subsequently revealed by etching the glass with HF. The technique was used to establish the nature and extent of reaction of curium oxide with aluminum oxide at 1650°C and to indicate the distribution of curium in several types of ceramic and cermet compacts. (auth)

10514 100 TO 1000 mW RADIOISOTOPE GENERATORS. Lyon, Warren C.; Bustard, Thomas S.; Hiebert, Adoniram C. (Hittman Associates, Inc., Baltimore). Nucl. Appl., 4: 79-87 (Feb. 1968).

The use of a radioisotope power source coupled to a thermoelectric converter represents one attractive technique for filling the need for a long-life reliable electrical power supply in the range from 100 to 1000 mW. Reliable supplies that require no maintenance for 5 years are available. Existing systems weigh 400 to 850 pounds and cost $12,000 to $15,000 per electrical watt. Systems weighing <10 pounds and costing $20,000 to $27,000 can be built using existing designs and technology. The radioisotope power supply is attractive for underwater power and other specialized applications where reliability, long life, low weight, or compactness is more important than cost. Radioisotope thermoelectric generators in this size range provide power from ~$0.27/Wh to $0.70/Wh, depending upon the design. The design characteristics of five typical generators are described. They include one-watt designs for oceanographic applications and a 300-mW design for an ordnance application. One generator is commercially available, while others are concepts. Characteristics of several other available generators are summarized. (auth)

10515 USING GAMMA RAYS FOR WASTEWATER TREATMENT. Ind. Water Eng., 4: 41(Sept. 1967).

The Metropolitan Sanitary District of Greater Chicago is studying the possibility of using γ radiation to help convert wastewater into water suitable for drinking and swimming. The γ rays will

not cause the treated water to become radioactive; consequently, it will be safe for swimming and to the fish population. Radiation would be used in combination with standard antipollution equipment. The radiation unit would be in the shape of a giant U-tube, built underground to protect persons on the surface, through which polluted water would be directed and treated by the γ rays. Research is being done on the application of radiation to the conditioning, stabilizing, and disinfecting of raw and digested sewage, sludge, and activated sludge. Research is also being undertaken to establish design criteria for treatment facilities aimed primarily at the effects of radiation on effluents containing cyanides, phenolics, and petroleum-related wastes. (BBB)

10516 GAMMA RADIATION FROM CYLINDRICAL SOURCE. Abrams, I.; Kalis, H.; Pelekis, L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 5-9 (1967). (In Russian).

A method has been developed for counting the dose rate and the flux of gamma-rays inside a cylindrical source on the symmetrical axis of the cylinder. (tr-auth)

10517 SEPARATION OF TIN ISOTOPES FOR MOESSBAUER STUDY. Aratani, Michi; Sano, Hirotoshi (Ochanomizu Univ., Japan). Radioisotopes (Tokyo), 16: 417-22(Sept. 1967). (In Japanese).

Isotope separation of ^{118}Sn and ^{119}Sn was performed and a ^{119m}Sn γ source prepared for the Moessbauer study of the 23.8-keV first-excited state of ^{119}Sn nucleus. ^{118}Sn as the starting material for the γ source and ^{119}Sn for the absorber were separated by means of an electromagnetic isotope separator using solid $SnCl_2$ at high efficiency in effective ion (Sn^+) production. ^{119m}Sn was produced by the nuclear reaction $^{118}Sn(n,\gamma)^{119m}Sn$. $^{118}SnO_2$ was irradiated with neutrons in a reactor. The 23.8-keV γ rays are superposed with Sn K x rays, but they are absorbed with 60μ thick Pd foil. Use of x rays eliminated the γ rays, the Moessbauer spectrum was observed on the set of the $^{119m}SnO_2$ source and the $^{119}SnO_2$ absorber. Isotopic composition in the source, distribution of the radiating atoms in the source, and the crystal structure of source compound are important factors. (auth)

10518 RAPID TREADWEAR RATINGS WITH RADIOACTIVE ISOTOPES. Gehman, S. D.; Reilly, P. J.; Larsen, G. M. (Goodyear Tire and Rubber Co., Akron, Ohio). Rubber Chem. Technol., 40: 969-83(Sept. 1967).

Incorporation of radioisotopes in small surface areas of tire treads permitted wear measurements by counting before and after wear. The isotope is limited to a depth of about 10 mil so that the fraction of activity worn off is appreciable in a hundred miles or so. Such experiments were made with ^{35}S, ^{65}ZnO, and ^{125}I. The first 2 isotopes were applied to uncured tires in thin sheets chemically identical to the tread compounds. The ^{65}Zn was counted with a shielded G–M tube. For ^{35}S, miniature specimens were cored from the tire treads, dissolved in hot xylene, and counted in an automatic liquid scintillation counter. Filter paper was laminated to aluminum foil and dipped in a solution of ^{125}I in toluene. Small disks or strips were applied to tire treads, usually after a break-in run of several hundred miles. The ^{125}I diffused rapidly into the rubber, combining stably in some compounds and otherwise being fixed by subsequent application of a solution of silver perchlorate in toluene. Counting was done with a scintillation probe. Wear calibration curves were secured by controlled grinding and counting of a similarly tagged specimen of each tread compound. Radioactivity in a tire tagged by strips across the tread at 5 places was about 2 μCi. Results correlated well with conventional techniques. (BBB)

10519 RADIOISOTOPE-POWERED HEART PUMP. Med. Res. Eng., 6: 48(Third Quarter 1967).

Design studies for a radioisotope engine to power pumps which would assist or replace functions of a diseased or damaged heart are discussed briefly. The engine, to be implanted in the abdominal area by surgery and measuring 5 in. or less in dia, would help rehabilitate critically ill heart patients. The heat from the decay of the radioisotope would be used by a thermodynamic converter to provide power for the heart pump. The encapsulated heat source might be ^{238}Pu, ^{147}Pm, or ^{171}Tm. Other components of the engine would include a heat exchanger using blood as the cooling medium and a control system to regulate the power output of the engine. The engine would supply a variable power output between 1 and 7 W. A study of various radioisotope engine designs is being conducted to arrive at least one optimum design and to identify major problems which will have to be solved in the development of such engines. (BBB)

10520 EFFECT OF THE SURFACE DIFFUSION ON THE SEPARATION EFFICIENCY IN GASEOUS DIFFUSION. Fiocchi, R. (Univ., Milan). Energ. Nucl. (Milan), 14: 713-16(Dec. 1967).

The dependence of the theoretical total separation efficiency (due to surface and gaseous diffusion) on different approximations assumed for the factor ζ of Higashi is numerically investigated for the UF_6 isotopic mixture. For one of the most reasonable values of ζ a comparison is established between granular and capillary description of the porous barrier. (auth)

10521 ISOTOPES AND RADIATION TECHNOLOGY. Volume 5, Number 1. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Miller, F. J.; Rupp, A. F. (eds.). Contract W-7405-eng-26. One of the Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Fall 1967. 93p. GPO $0.70 Domestic, $0.90 Foreign.

A separate abstract was prepared for each of the 9 sections of this review. (R.C.K.)

For abstracts of individual sections see: 10268, 10269, 10442, 10508, 10509, 10522, 10523, 10545, and 10767.

10522 MAIL-SORTING APPARATUS USING RADIOISOTOPE-GENERATED X-RAY FLUORESCENCE. Gerrard, Martha (Oak Ridge National Lab., Tenn). Isotop. Radiat. Technol., 5: 1-2(Fall 1967).

A mail-sorting system based on x-ray fluorescence generated by the bremsstrahlung from a ^{147}Pm/Al source was developed. The prototype unit was operated by a technician with limited training and handled 10^7 letters in a 500-hr period without difficulty. Production units could be built for about $5,000. (auth)

10523 AEC ACTIVITIES. Isotop. Radiat. Technol., 5: 63-89(Fall 1967).

Topics covered include: isotope production and materials development; thermal applications of radioisotopes; radioisotope uses in aerospace, criminalistics, environmental studies, oceanography, pollution, and other technologies; radiation processing applications, radiation preservation of foods, licenses and contracts, and availability of isotopes and services. (M.C.G.)

Materials Testing

Refer also to abstracts 10501, 12192–12194, and 12198.

10524 (ORNL–4176) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending August 31, 1967. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 85p. Dep. CFSTI.

The Heavy-Section Steel Technology Program for the investigation of the structural behavior of thick light-water cooled nuclear reactor pressure vessels is described. First, engineering methods in current use on thinner vessels will be evaluated for their applicability to thicker vessels. Then, a thorough mechanical properties testing program will be undertaken which will include full sized vessel tests as well as tests of steel plates. Ultrasonic inspection of program plates, before and after heat treatment, has already been done. Plate specimens for testing have been fabricated. Two research programs to investigate the effects of irradiation on fracture toughness of thick pressure vessel plates are underway. Planned activities for determining actual pressure vessel behavior are outlined. (L.C.L.)

10525 (UCRL–Trans–10185) MATERIAL TESTING PROCEDURE. Kaiser, J. Translated by E. Myers for Univ. of California Lawrence Radiation Lab., Livermore, from German Patent 852771. 15p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

A material testing procedure is described in which the frequency and/or amplitude and/or number of sound effects occurring when the specimen is stressed are determined and evaluated to indicate previous stressing, macroscopic internal stresses, annealing after previous stressing and stress limits for elastic limit, rupture limit, tearing limit and yield point. The equipment consists of an indicator, preferably a piezocrystal to convert sound effects produced by stress into electrical vibrations, a voltage amplifier, and an indicator. (F.S.)

10526 ON THE DETERMINATION OF THE OPTIMAL INTEGRATION TIME CONSTANTS IN TRANSMISSION TECHNIQUE OF MATERIALS TESTING. Irmer, K. (Technical Univ., Dresden). Isotopenpraxis, 3: 417-18(1967). (In German).

A continuous materials testing apparatus consisting of a ^{60}Co source, a scintillation detector, and a recorder is described. The output of the scintillation counter is transformed by means of an integration circuit into a voltage which registers on the recorder. The time constant of the integration circuit controls the accuracy

of the testing method. Therefore, a simple linear equation was derived which related the integration time constant to the smallest detectable void length in the direction in which the material is moving, the velocity of the material, and the width of the test beam. (L.C.L.)

10527 SURVEY OF NONDESTRUCTIVE TEST METHODS. Cofield, R. E. (Union Carbide Corp., Oak Ridge, Tenn.). Instrum. Technol., 14: 38-44(Nov. 1967).

Methods and equipment for detection of mass deficiency, discontinuities, homogeneity, composition, grain size, coating thickness, and dimension measurements by nondestructive testing are reviewed. Test methods include the use of sensing media such as penetrating radiation (x, γ, and β rays), neutrons, ultrasonic or high frequency sound waves, microwaves, electromagnetic fields, magnetic flux, and thermal or ir energy. As examples, after penetrating radiations or neutrons are passed into the test object, some of the possible information-bearing interactions that may occur are examined. The radiation interaction characteristic of the test object determines the number and energy of the rays which pass through. The production of prompt or delayed secondary radiation in the test object may be detected by x-ray emission spectrometry, activation autoradiography, or activation analysis. In radioactivity measurements and autoradiography, the quantities and energy of an inherent property of the test object (its radioactivity) may be sensed and the effects of coatings, impurities, or inhomogeneities on this radiation studied. Area radiation imaging, a technique in which all or an appreciable area of the test object is penetrated, and the resultant transmitted radiation are registered on an area detector as a plan view of internal opacity is explained. Other tests with penetrating radiation discussed include microradiography, dynamic or flash radiography, narrow-beam radiation absorption gauging, x-ray diffraction in crystals, β-backscattering techniques, and radiation emission testing. (BBB)

Protective Structures

Refer also to abstract 10425.

10528 (EGG-1183-1334) EXPERIMENTAL MEASUREMENT OF FALLOUT PROTECTION PROVIDED BY TRANSPORTATION VEHICLES. Report No. L-853. Summers, R. L. (EG and G, Inc., Las Vegas, Nev.). June 30, 1967. Contract AT(29-1)-1183. 20p. Dep. CFSTI.

Experimental measurements of fallout protection provided by a school bus and two standard buses were made using the Mobile Radiological Measuring Unit. This unit hydraulically pumps a ^{60}Co source through a length of tubing placed over the ground to simulate a uniform distribution of radioactivity. Two sources were used to simulate the fallout field. Protection factors were determined at different locations in the buses. (F.S.)

10529 (ORNL-CD-2) INDEXES TO 780 UNCLASSIFIED DOCUMENTS ON CIVIL DEFENSE. Levey, Joanne S.; Klein, Ann S.; Nelson, Joanne H. (eds.) (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 212p. Dep. CFSTI.

A bibliography containing 780 references to reports and published literature on various aspects of civilian defense is presented. The bibliography contains bibliographic, keyword, corporate author, and personal author indexes. (R.C.K.)

Radioactive Material Handling

Refer also to abstracts 10449, 10472, 10473, 10779, and 12087.

10530 (IDO-12040(Suppl.2)) RADIOACTIVE WASTE DISPOSAL DATA FOR THE NATIONAL REACTOR TESTING STATION, IDAHO. Osloond, Joe H. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Nov. 1967. 19p. Dep. CFSTI.

Information is presented on the quantities, type, and disposition of radioactive waste associated with reactor operations or research projects during the calendar year 1966. The radioactive wastes are identified according to physical form, nuclide content, and the facility or area originating the waste. Previously published reports contain radioactive waste disposal data for the years 1955 through 1965. (auth)

10531 (ORNL-4059) FIXATION OF INTERMEDIATE-LEVEL RADIOACTIVE WASTE CONCENTRATES IN ASPHALT HOT-CELL EVALUATION. Goode, J. H.; Flanary, J. R. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 32p. Dep. CFSTI.

Hot-cell tests were made, over a period of 9 to 15 months, to determine the effects of internal irradiation on the leaching rates of sodium and fission products from asphalt-waste products containing 60 wt % solids and as much as 52 curies of aged mixed fission products per gallon of asphalt product. These products were prepared by incorporating three typical varieties of intermediate-level radioactive liquid wastes—ORNL waste evaporator concentrate (ILW), simulated aluminum cladding solution (ACS), and neutralized Savannah River Plant Purex second-plutonium-cycle concentrate (2CW)—and fission products, in the form of a Purex first-cycle waste from Hanford, into type RS-2 emulsified asphalt. Both water and water containing 100 ppM of NaCl were used to leach samples of these products; no significant difference was noted between the rates obtained for each leachant. Sodium and ^{137}Cs were leached at rates ranging from 1×10^{-4} to 4×10^{-4} g cm^{-2} day^{-1} for absorbed doses of up to 6.9×10^{7} rads. The rates for ^{90}Sr, ^{106}Ru, and rare earths were lower by one to two orders of magnitude. No swelling or net evolution of gas was observed. Photographs of cross sections of asphalt products that had been stored for periods of up to nine months showed no swelling; however, bubbles less than 1 mm and about 5 mm in diameter were observed in the ILW and 2CW products, respectively. (auth)

10532 (ORNL-4070) MANAGEMENT OF RADIOACTIVE WASTES AT NUCLEAR POWER STATIONS. Blomeke, J. O.; Harrington, F. E. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 102p. Dep. CFSTI.

The management of wastes produced at nuclear power plants may become an increasingly significant problem in an economy which is expected to grow to 50 times its present size within the next 13 years. As a preliminary step in assessing future implications, the operating experience in waste management is reviewed at the Dresden-I, Big Rock Point, Humboldt Bay, Elk River, Indian Point-I, and Yankee power stations. All these plants have operated within the limits authorized for release of radioactive wastes to the environment at costs which are estimated to range between 2 and 10% of their total annual operating costs. The maximum annual average releases of gaseous activation products and noble gases have ranged from 22 curies/yr (0.7 μc/sec) at Yankee, to 35,000 μc/sec at Big Rock Point. The releases varied from a maximum of 0.0026% of the limit at Indian Point to as much as 28% of the limit at Humboldt Bay. Releases of halogens and particulates in the gaseous wastes ranged from about 2×10^{-3} μc/sec at Indian Point to nearly 1.2 μc/sec at Big Rock Point, corresponding to about 10^{-5}% and 30% of the respective limits. The average activity released annually in liquid wastes varied from 0.01 curie at Yankee and Elk River to 11.1 curies at Indian Point, exclusive of tritium. On the basis of an allowable continuous discharge of activity at an average concentration of 10^{-6} μc/cc, the releases have ranged from as little as 0.0002% of the limit at Elk River during a 12-month period in 1962–63, to as much as 9.9% of the limit at Big Rock Point in 1966–67. The concentration of tritium in the wastes has not been routinely determined in the past, but recent analyses give evidence that 5 to 20 curies have been released annually by each of the BWR stations, and about 500 and 1300 curies have been discharged annually at Indian Point and Yankee respectively. Tritium has been released at much less than 1% of its limit in all cases. The annual volumes of solid wastes have ranged from several hundred to several thousand cubic feet and for the most part have been of a very low activity level. These wastes are routinely shipped off-site for disposal in commercial burial grounds by licensed contractors. It is concluded that waste management practices at light-water power reactor stations have been quite adequate in the past, and there are no future problems anticipated in this area that will not be resolved in the normal course of an expanding industrial technology. (auth)

10533 REDUCTION OF AMBIENT AIR CONCENTRATIONS OF POLLUTANTS BY DISPERSION FROM HIGH STACKS. Smith, M. E. Nucl. Safety, 9: 46-53(Jan.-Feb. 1968).

Stacks that reach 500 ft or more above ground have become symbolic of good industrial air-pollution practice. Current knowledge on the benefits and limitations associated with high stacks is reported. Unresolved questions about stack gas behavior, including plume rise, inversion breakup fumigations, and the effects of major terrain features are reviewed. There is no question that the high stack is an extremely effective device for reducing ground-level concentrations, but additional study is needed to make sure that stacks are fully exploited. (auth)

10534 REMOVAL OF RADIOACTIVE PHOSPHORUS FROM SEWAGE BY ACTIVATED SLUDGE. Srinath, E. G.; Bai, B. Meera; Pillai, S. C. (Indian Inst. of Science, Bangalore). Water Waste Treat., 11: 410-14(Sept.-Oct. 1967).

Factors influencing the removal by activated sludge of radiophosphorus added to raw sewage were studied. Results showed that the rapid removal of the ^{32}P is largely due to the Vorticellid protozoa, such as the Epistylis species, in the sludge. With in-

creasing concentration of activated sludge, as with the protozoan, up to 15% (v/v), there was increasing removal of ^{32}P, especially in the early stages of the aeration period. With higher concentrations of activated sludge and of protozoan cells (20, 25, and 30%), the extent of removal of ^{32}P was practically the same. The factors which adversely affected the activated sludge in the removal of ^{32}P also affected the protozoa. The efficiency of the bacteria isolated from the activated sludge in the removal of ^{32}P from the sewage was poor. The radiophosphorus removed from the supernatant liquid was concentrated in the sludge or in the protozoan material and from these materials, a small part of the ^{32}P dialyzed out over a period of 24 hr. (BBB)

Vacuum Engineering

Refer also to abstract 10440.

10535 INTERNATIONAL SYMPOSIUM ON SORPTION–DESORPTION PHENOMENA IN HIGH VACUUM, ROME, 14TH–17TH MARCH 1967. Nuovo Cim., Suppl. (1), 5: 287-619(1967). (CONF-670326).

Separate abstracts were prepared for ten of the twenty-nine papers presented at the conference. The other nineteen papers were not in scope for NSA. (W.D.M.)

For abstracts of individual papers see: 10963–10965, 11011–11015, 11095, and 11218.

10536 VACUUM AS AN INSULATOR. AN INDEXED BIBLIOGRAPHY. Hawley, R.; Maitland, A. London, Chapman and Hall Ltd., 1967. 123p. 30s.

A bibliography is presented which contains 556 journal references on vacuum as a basic insulating medium. References are listed in alphabetical order under the first author's name. References are followed by a series of subject index numbers which correspond to the subject division shown in a list at the end of the bibliography. A cross index, grouping the publications containing information on a specific topic is given. A list of all publications reviewed is also provided. (F.S.)

INSTRUMENTATION

Radiation Detection Instruments

Refer to abstract 10526.

General Detectors and Monitors

Refer also to abstracts 10782, 11495, 11819, and 12087.

10537 (AAEC/TM-403) THEORETICAL INVESTIGATION OF ABSOLUTE NEUTRON DETECTION. Dalton, A. W.; Lam, K. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sept. 1967. 26p. Dep.

A survey was made of the detection systems classified as flat response in order to establish their use in high accuracy measurements of absolute neutron intensities for a wide range of neutron sources. Two detection systems involving neutron moderation in either graphite or an hydrogenous material were selected as having the most suitable characteristics. Numerical solutions of the neutron transport equations for these systems were computed to determine the conditions required to produce minimum variation of efficiency with energy. It was shown that, with the suitable choice of moderator composition and size, it should be possible to reduce these errors to less than one percent over the energy range 100 eV to 4 MeV. (auth)

10538 (CEA-R-3321) ENSEMBLE DE DETECTION DU TRITIUM AVEC PHOTOMULTIPLICATEUR FONCTIONNANT EN COURANT. (Tritium Detection Assembly with a Current Photomultiplier). Tabot, Leon (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 16p. (In French). Dep.

The difficulties of carrying out counting measurements on surface scratches in the case of high contamination of the surfaces controlled are considered. A dosage method based on the measurement of the exit current of a photomultiplier is described. The principle, an assembly diagram, and experimental results are given. (auth)

10539 (DUN-SA-49) FIXED RADIATION MONITORING SYSTEM. Schwietert, W. E. (Douglas United Nuclear, Inc., Richland, Wash.). Apr. 1967. Contract AT(45-1)-1857. 64p. Dep. CFSTI.

The Fixed Radiation Monitor System used by Douglas United Nuclear is described. The monitoring system consists of ionization chambers, logarithmic radiation monitors, alarms, and recording and transmitting equipment. (W.H.K.)

10540 (HW-SA-3671) RADIATION MONITORING: A PROGRAM OF SELF-INSTRUCTION. Cunningham, G. E.; Wade, James E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 1964. Contract AT(45-1)-1350. 193p. Dep. CFSTI.

A program of self-instruction in the subject of radiation monitoring is presented. The subject headings of the program are: Atomic Structure and Radiation, Radioactivity and Radiation, Ionization, Ion Chamber Theory, Scintillation Counters, Definition and Units, Exposure Controls, Radiation Zones and Radiation Zone Work, Radiation Detection Instruments, Beta-Gamma Detection Instruments, Alpha Detection and Measurement Instruments, Dose-Rate Measurement, Neutrons, and Neutron Detection and Measurement. (B.G.D.)

10541 (MIT-952-4, pp 267-99) INSTRUMENTATION TECHNIQUES. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

A method of correcting data from angular correlation experiments for the finite size of the source and the detectors is presented. Further progress has been made on the adaptation of an incremental magnetic tape recorder in a multichannel analyzer-computer interface system. (auth)

10542 (TID-24212) SPARK COUNTER NEUTRON DETECTOR FOR HIGH-TEMPERATURE APPLICATIONS. Annual Summary Report, September 1, 1966-July 29, 1967. Eichholz, Geoffrey G. (Georgia Inst. of Tech., Atlanta). Contract AT(40-1)-3563. 33p. Dep. CFSTI.

Spark counters of the corrugated electrode type have been designed and tested for use as neutron detectors in high neutron fluxes and at high temperatures. Work done in the first stages of this project has been concerned with the separate study of neutron detection operating characteristics for different counter configurations and electrode spacings and with the investigation of the effect of temperature on counter operations. Using four boron nitride converter disks in a 2-inch detector, efficiencies of the order of 10^{-7} counts/neutron were obtained. Operating the counters at temperatures up to 400°F, downward shifts in operating voltage were observed but no appreciable loss in sensitivity, in neutron fluxes of the order of $10^{6}-10^{7}$ neutrons/cm^{2}sec. Higher flux measurements were deferred until the effect of neutron heating in the boron nitride disks could be determined. It was found that a boron nitride disk mounted between two aluminum washers incurred a temperature rise of only 14°F above the ambient graphite plug temperature in a flux of 10^{13} n/cm^{2}sec. Higher flux exposures of the neutron detector itself are consequently in progress. (auth)

10543 (UJV-1873) PREPARATION AND USE OF LITHIUM-DRIFTED GERMANIUM DETECTORS. Srnka, D. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 23p. Dep.

Detailed fabrication techniques for planar and coaxial lithium-drifted germanium detectors are described. For cooling germanium detectors the small vacuum cryostat was designed. Coaxial type detector with active volume of 3.5 cm^3 was made by lithium drifting process in boiling pentane. The FWHM energy resolution with an E810F preamplifier was 4.2 keV for 1.333 keV gamma rays with a detector bias of 1.750 V. (auth)

10544 (WAPD-TM-670) EFFECTIVE CADMIUM CUTOFF ENERGIES FOR FINITE CYLINDRICAL FILTERS WITH FINITE-SIZE DETECTORS. LSBR/LWBR Development Program. Glickstein, S. S.; Hall, W. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT(11-1)-Gen-14. 31p. Dep. CFSTI.

Curves and tables were compiled to aid the experimenter in evaluating cadmium-cutoff energies appropriate to the experimental situation. Results are presented for finite cylindrical cadmium filters with an isotropic flux incident on a point detector located at the center or off the center of the filter. Finite-size detector calculations are also shown, as well as results for some cases of anisotropic incident fluxes. (auth)

10545 ANGER CAMERA. Carden, Joan E. Isotop. Radiat. Technol., 5: 45-53(Fall 1967).

Isotope or organ visualization with a radioisotope scintillation camera—an instrument which has a detector that is fixed in relation to the patient and which produces pictures called images—is a diagnostic technique for determining the localization of a small quality of gamma-ray or positron-emitting isotope administered to a patient. A specific radioisotope camera, the Anger camera developed by Hal O. Anger, University of California, Berkeley, is described in detail. The description of the camera is followed by citations of some selected instances in which the Anger camera has been used. (auth)

10546 FUNDAMENTALS OF ESTIMATION OF ERROR STATISTICS IN NUCLEAR RADIATION MEASUREMENT TECHNIQUE. PART V. Weise, Lothar (Kernforschungsanlage des Landes Nordrhein-Westfalen, Juelich, Ger.). Arch. Tech. Messen, No. 379, 173-8(Aug. 1967). (In German).

The author discusses a general procedure for evaluation of the parameter vectors from observations of the observation vector by means of probability density procedures. The observation vector includes an unavoidable measurement error. It is the realization of stochastic variables which are obtained by repeated measurements made under identical conditions. The ideal and unreal system is replaced according to a principle that takes into consideration the fact that only probabilistic conclusions can be drawn about the parameters. The starting point is a probability density that describes either a discrete or a stationary probability distribution of the observation vector in a dimensioned vector space, and depends on the dimensional parameter vector. In a discrete probability distribution the probability density represents the probability that the observation vector resembles the true value. In a stationary probability distribution the probability density is the probability that the observation vector lies between the vector and an increment of the vector. The objective of the calculation then is to evaluate the parameter vector by probabilistic means. The author describes a general procedure for obtaining evaluations of the parameters. (BBB)

10547 PHOTOELECTRIC DETECTORS FOR 10 TO 400 A PHOTONS. Grodski, Juliusz J. (Univ. of Waterloo, Ont.). Norelco Rep., 14: 107-11(July-Dec. 1967).

Practical aspects of the photoelectric effect in the wavelength region from 10 to 400 Å are discussed, with particular attention to the photoelectric yield of metals. The four basic types of photoelectric detectors for ultrasoft x-radiation are reviewed. The photoelectric detectors differ from each other by the method in

which the photoelectric signal is collected and amplified to a level for which standard counting instrumentation can be used. In general they give lower signal-to-noise ratio than the elaborate gas ionization detectors, particularly in the region up to 100 Å. However, above 100 Å, these detectors are used almost exclusively. They are characterized by fast pulse rise time permitting much higher counting rates than is possible with such detectors as Geiger or proportional counters. (BBB)

10548 "LOTUS" NUCLEAR COUNTER ARRAY. Engineer, 224: 421(Sept. 29, 1967).

Engineering aspects of Lotus (the latest counter array to be installed for experimental work at Chalk River Nuclear Laboratories, Canada) are outlined here. Lotus was designed to make angular correlation measurements with the laboratory's Van de Graaff accelerator. Targets of gaseous or solid material are placed at the center of the array and irradiated by a beam from a Van de Graaff accelerator. The resulting radiation is detected by 7 sodium-iodide scintillation counters which may be individually positioned in a spherical region around the target. In comparison with most correlation measurements using 2 counters, the use of 7 allows 21 times as many measurements to be made simultaneously. The array is constructed so that each counter, together with its lead shield, photomultiplier tube, and preamplifier, is able to move in 3 dimensions in space while pointing at the center. Such freedom is made possible by mounting each counter in a sleeve that telescopes radially from the center. Lotus is 12 ft 6 in. in height and weighs 8.8 t, the overall dimensions of the array being dictated by the size of the scintillation counters and associated equipment. (BBB)

10549 A PROPORTIONAL COUNTER FOR ASSAYING ^{14}C AND TRITIUM IN THE EFFLUENT OF A GLC COLUMN. Karmen, Arthur (Johns Hopkins Medical Institutions, Baltimore). J. Gas Chromatogr., 5: 502-5(Oct. 1967).

A technique is described for assaying ^{14}C and ^{3}H radioactivity in the effluent of a gas-liquid chromatography (GLC) column in which a conventional thin-window, gas flow proportional counter is used to detect the radioactivity. The column effluent is passed through a combustion tube in which organic compounds are converted to carbon dioxide and hydrogen before delivering them to the counter. To minimize changes in gas composition in the counter that occur during elution of unlabeled peaks, carbon dioxide is used as carrier gas and an accessory diluting gas flow is added to the gas stream just before it enters the 50-ml detector. This resulted in improved insensitivity to the elution of unlabeled compounds while the efficiency of the detector for ^{14}C was comparable to those of other methods previously reported. (BBB)

10550 PROPORTIONAL COUNTER RESOLUTION. Campbell, A. J. (Cambridge Instrument Co., Eng.). Noreico Rep., 14: 103-6(July-Dec. 1967).

The usefulness of counters as energy spectrometers is severely limited by their poor energy resolution, and it is important to establish whether the resolution is limited by fundamental statistical effects or merely by experimental imperfections. A theory is outlined which should be applicable to solid state devices which may become available and should enable the potential usefulness of such devices to be assessed at an early stage in their development. For an Ar counter it is shown that the relative standard deviation, $\sigma_p/\overline{P}$, of the pulse height distribution is greater than $0.11\ E^{-\frac{1}{2}}$ (where E is the x-ray energy in keV). It is unlikely that any other gas would give a substantially narrower distribution. The skewness, γ_p, of the distribution was also calculated, and in Ar $\gamma_p \cong 0.42\ \sigma_p/\overline{P}$. (BBB)

10551 PREAMPLIFIER FOR SEMICONDUCTOR RADIATION DETECTORS. Boucek, J. (Charles Univ., Prague). Jad. Energ., 14: 31-3(1968). (In Czech).

Preamplifiers are described which have been used in p-i-n simiconductor detectors developed in the Institute for Biophysics. The preamplifiers have been designed using E 180F and E88CC tubes. The reasons for the choice of these tubes and tables of measured characteristics are presented. (auth)

10552 EXPOSURE OF DEFECTS IN SILICON p–i–n RADIATION DETECTORS. Yuskeselieva, G. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 255-9(Feb. 1967). (In Russian).

Certain defects of the p-n junction in p-i-n silicon detectors were revealed in the course of the formation of radiative-sensitive zones. The results are reported of studies on the exposure of defects in p-type Si monocrystal during Li ion drift. The defects were exposed with the aid of dry and wet electrophotographic developers and electrochen.ical Cu deposition on Si wafers. Diffusion of Li was carried out at 263°C in Ar atmosphere. The observed defects spread in the direction opposite to that of the Li ion drift and extend only to the n-junction. The defects result in increased reverse current values which fail to return to the original values regardless of subsequent surface treatment. (JPRS)

10553 APPLICATION OF GERMANIUM RADIATION COUNTER TO MEASUREMENT γ-RADIATION FROM INELASTIC NEUTRON SCATTERING. Musaelyan, R. M.; Popov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 252-4(Feb. 1967). (In Russian).

Germanium-based semiconductor counters (1.2 mm thick, resolution = 8 keV; and 1.4 mm thick, resolution = 4-5 keV) were made and used to measure the γ-ray spectra of ^{19}F and ^{127}I using neutrons at 570 and 850 keV produced in (p,xn) reactions. A good effect-to-background ratio was obtained under conditions of close geometry without protection of the detector from the neutron beam. The method requires small amounts of materials (several grams), and can be used with separated isotopes. (JPRS)

10554 INSTRUMENTAL DESIGN IN ANALYSIS OF $^{14}CO_2$ IN EXPIRED AIR IN MAN. Blomstrand, R.; Carlberger, G. (Karolinska Institutet, Stockholm). Scand. J. Clin. Lab. Invest., 19: 313-18(Aug. 1967).

A simple instrument system was designed for use with clinical studies, utilizing only a few μCi of ^{14}C-labeled compounds in patients, to measure expired $^{14}CO_2$. In many metabolic studies on patients it is desirable to limit the dose of ^{14}C-labeled compounds, and for such studies a 15-l ionization chamber coupled with a sensitive vibrating-reed electrometer, proved to be a convenient measuring device. Only minute amounts of $^{14}CO_2$ could be expected in the expired air. With the instrumental design described, a concentration of 0.08 nCi/l sweeping air through the ionization chamber increased the signal 100% above the background. This corresponded to an expiration of about 0.5 nCi/min from the patient, which usually represented a metabolic rate of less than 1%/hr of the administered radioactivity. The instrument consists of a sensitive $^{14}CO_2$ detector; a CO_2 analyzer; pressure, temperature, and flow meters; a timer; and an O_2 analyzer. The apparatus is equipped with 2 alternative flow systems for continuous determination of $^{14}CO_2$, CO_2, and O_2 in expired air. The $^{14}CO_2$ excretion is determined by an ionization chamber, and CO_2 electrode or by means of IR absorption. The sensitivity and the reproducibility of the technic used were indicated from studies on the oxidation of ethanol-1-^{14}C (2 μCi) intravenously, the average recovery of the injected radioactivity was 62.5 ± 6.4% (mean ± standard deviation). (BBB)

10555 PREPARATION OF LITHIUM-DRIFTED SILICON DETECTORS. Przyborski, Wincenty; Chwaszczewska, Janina; Czarnacki, Wieslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 993-1005(1967).

The results of a study of lithium mobility in boron and gallium doped silicon single crystals grown either by zone floating or Czochralski's methods are given. The influence of dislocations on the drift process, compensation quality and reverse current of Li-drifted diodes is outlined. A description of the Li-drifted detector preparation technique, involving some novelties, is presented. (auth)

10556 SIMPLE METHOD OF PRODUCTION OF LITHIUM SURFACE BARRIER SILICON DETECTORS. Wilhelmi, Z.; Kaminski, A.; Marcinkowski, A.; Modelska-Berkan, A.; Czyzewski, T. (Warsaw Univ.). Nukleonika, 12: 985-91(1967). (In Russian).

A simple method of production of lithium surface barrier silicon detectors is described. By means of this method silicon detectors with a thickness up to 4 mm and of a sensitive area up to 2 cm^2 were produced. The detectors give resolutions of 18–25 keV on 976 keV internal conversion electrons and of 35–40 keV on 8.78 MeV alpha particles when operated at room temperature. (auth)

10557 OPEN CYLINDRICAL COUNTER WITH QUENCHING VAPOR ABOVE THE FREE SURFACE OF LIQUID (DETECTOR OF EXOELECTRONS). Sujak, B. (Univ., Wroclaw. Pedagogical Coll. of Opole, Poland); Pietrzak, R.; Stepniowski, I. Acta Phys. Pol., 32: 949-57(Dec. 1967).

An open cylindrical counter with the quenching vapor above the free surface of liquid has been constructed. This type of counter can be applied with success for detecting exoelectrons. The relative slope of its characteristic curve is about 0.1%/V, the plateau length is approx. 100 V and the dead time is approx. 1.5×10^{-4} sec at an operating voltage of about 2800 V. The effect of the geometry and operating temperature on the properties of an experimental counter has been investigated. (auth)

10558 IDENTIFICATION OF ISOTOPES OF ENERGETIC PARTICLES WITH DIELECTRIC TRACK DETECTORS. Price,

P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Fleischer, R. L.; Peterson, D. D.; O'Cealaigh, C.; O'Sullivan, D.; Thompson, A. Phys. Rev., 164: 1618-20(Dec. 25, 1967).

A new principle of charged-particle identification by plastic track detectors is described. It was found that the rate of chemical etching (by a suitable reagent) along the track of a heavy ion in a plastic depends only on the primary ionization rate, which, as the particle slows down, increases at a rate that depends uniquely on atomic number Z and mass A. To identify the Z, A, and energy of a particle the etching rate at a known residual range [by analogy with a (dE/dx) – E detector] or the etching rate at two known points along the trajectory in a stack of plastics can be measured. Experimental data are presented for ^{10}B, ^{11}B, ^{12}C, ^{14}N, and ^{16}O ions from the Yale accelerator, showing that masses differing by 9% can be resolved. Unique features of this method are its discrimination against intense background radiation and its combination of high resolution with large collecting area, which make it feasible to do certain cosmic-ray experiments, such as the detection of ^{10}Be nuclei. (auth)

10559 OBSERVATIONS OF ~15 GeV COSMIC RAY PHOTONS BY MEANS OF A SPARK-EMULSION-CHAMBER. Kobayakawa, H.; Masaike, A.; Ohashi, Y.; Yokoi, K.; Yuda, T. (Nagoya Univ., Japan). Nucl. Instrum. Methods, 58: 289-92(Jan. 1968).

A new method of detecting high energy events has been developed by exposing an apparatus to cosmic ray electrons and photons at Mt. Norikura (730 g/cm^2). The apparatus consists of an emulsion chamber and spark chambers, and an electronic cascade shower developed in the former can be located with the aid of black spots marked on X-ray films inserted in the latter. It has been demonstrated that a cascade shower of energy down to ~15 GeV can be detected with considerable ease in the emulsion chamber. This method is thus proved useful in the investigation of high energy interactions. (auth)

10560 SPINNER AND SOME APPLICATIONS. Spadavecchia, A.; Hahn, B. (Univ., Freiburg i. B.). Helv. Phys. Acta, 40: 1063-79(Dec. 30, 1967). (In German).

A new kind of detector for rare nuclear processes, called the spinner, is described. The principle is to produce negative pressures in a liquid by centrifugal forces. The metastable state can be destroyed similar like in the normal bubble chamber by energy deposition by particles. The spinner has so far proven to be useful for the determination of spontaneous fission rates and for the detection of very low neutron fluxes. (auth)

10561 EFFECT OF RADIATION DAMAGE ON PLASTIC SCINTILLATORS. Oldham, G.; Ware, A. R.; Blackwell, S. A. (Loughborough Univ. of Tech., Eng.). Nucl. Energy, No. 6, 158-61(Nov.-Dec. 1967).

Plastic scintillator samples were prepared from poly(vinyltoluene) containing p-terphenyl and 2,2'-p-phenylenebis(5-phenyloxazole). The samples were exposed to a ^{137}Cs source and received doses, measured by Fricke $FeSO_4$ dosimeter, up to 5.5×10^6 rads. The irradiated scintillators were used to measure β-spectra from ^{35}S, ^{99}Tc, and ^{204}Tl, and the apparent maximum energies were determined after various doses. The percentage change in apparent maximum energy varied linearly with dose over the range studied, and was found to be similar for the three isotopes employed. (UK)

10562 LINEARITY AND ENERGY RESOLUTION OF A HIGH PRESSURE HELIUM GAS SCINTILLATION COUNTER. Morgan, G. L.; Walter, R. L. (Duke Univ., Durham, N. C.). Nucl. Instrum. Methods, 58: 277-81(Jan. 1968).

Studies were made of the linearity and energy resolution of a helium scintillation counter. The response to alpha particles of a mixture of 65 atm of He and 4.5 atm of Xe was found to be a linear function of energy down to alpha particles energies of 0.3 MeV, but with an intercept of 14 keV. The deviation from linearity below this energy was small. The energy variation of the resolution was found to be in good agreement with that expected from the combination of an energy independent contribution due to variation in light collection for different regions of the scintillator and of an energy dependent contribution due to the statistical fluctuations associated with the scintillation and light detection processes. (auth)

10563 SIMPLER APPROACH TO THE GEOMETRICAL EFFICIENCY OF A PARALLEL-DISK SOURCE AND DETECTOR SYSTEM. Ruby, L.; Rechen, J. B. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 58: 345-6(Jan. 1968).

A little-known integral formulation, of considerable simplicity, has been used to compute representative values of the average solid angle subtended at a disk source by a coaxial parallel-disk detector. The advantage of the integral formulation is compared with a Monte Carlo calculation of the solid angle. It is concluded that the Monte Carlo calculation is of lesser advantage, but is more easily adaptable to complex geometries. (auth)

10564 A NEW METHOD FOR CHARGE DETERMINATION OF HEAVY, COSMIC RAY PARTICLES. Benton, E. V.; Henke, R. P. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 58: 241-4(Jan. 1968).

A method of particle track analysis is presented for accurately (±1 in Z) measuring the charge spectrum of cosmic rays using stacks of dielectric detectors. (auth)

10565 CORRECTION FOR THE RADIAL DEPENDENCE OF THE GAMMA COUNTER EFFICIENCY IN FAST FISSION RATIO MEASUREMENTS. Maracci, G.; Rustichelli, F. (CCR EURATOM, Ispra, Italy). Nucl. Instrum. Methods, 58: 269-73 (Jan. 1968).

An expression of the correction factor for the radial dependence of the gamma counter efficiency in fast fission ratio measurements was derived as a function of experimentally determinable quantities. The evaluation of this factor in one practical case has shown that the fast fission factor δ^{28} can be determined also by using foils of big diameter in correspondence with crystals of relatively small diameters, without affecting the accuracy or dissolving the detector foils. (auth)

10566 STATISTICAL EXAMINATION OF COUNTING RESULTS WITH RADIATION MEASUREMENTS. Plesch, R. (Wernerwerk fuer Messtechnik der Siemens AG, Karlsruhe, Ger.). Kerntechnik, 9: 503-7(Nov. 1967). (In German).

After a brief summary of the results of the theory or errors, a statistical test number is introduced which allows to estimate quantitatively the statistical quality of the distribution of measured values. The nonstatistical influences and their perceptibility are discussed theoretically and by means of numerical examples. (auth)

10567 THE CASACCIA CENTER'S WHOLE-BODY COUNTER. Clementi, Gianfelice (CSN, Casaccia, Italy). Com. Naz. Energ. Nucl., Notiz., 13: No. 11, 37-40(Nov. 1967). (In Italian).

The W.B.C. in operation at the Casaccia Nuclear Research Center, the construction of which was decided in 1961, is described in detail. It quotes the design specifications, shielding, conditioning, detector and geometry, anti-claustrophoby measures, and instrumentation. Also the technical characteristics of the unit and some sample measurements are shown. (auth)

10568 IMPROVEMENTS IN AND RELATING TO SCINTILLATORS FOR MEASURING IONISING RADIATION AND METHODS OF MANUFACTURING THE SAME. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,097,005. Dec. 29, 1967. Filed Mar. 10, 1966.

A method of forming a protective layer on a scintillator body consists of forming on at least one surface of the body a layer of a compound having an isocyanate group at each end of the molecule and exposing the layer to water vapor to polymerize the layer. The protective layer has a depth of 30μ at most. The compound forming the layer is formed by the reaction of a polyether and a polyisocyanate. (B.L.M.)

10569 RADIATION DETECTOR READOUT SYSTEM. Cashion, Kenneth D.; Baker, Benny R. (to National Aeronautics and Space Administration). U. S. Patent 3,358,145. Dec. 29, 1964.

A radiation detector readout system for converting radiation into light and measuring this light is described. The system is composed of a photomultiplier tube, an integrating circuit, related switching circuits, and circuitry for minimizing background noise. (TSS) (U.S. Pat. Gazette)

10570 ADJUSTABLE MOUNTING FOR PLASTIC PHOSPHOR SCINTILLATION DETECTORS. Keck, Charles R.; Jordan, Paul W. U. S. Patent 3,358,144. Dec. 21, 1965.

An adjustable mounting system for scintillation detectors, photomultiplier tubes, and related circuitry is described. The detectors are positioned in a horseshoe configuration. Spring pressurizing means are described for connecting the scintillators and the electron tubes. (TSS) (U.S. Pat. Gazette)

10571 MOUNTING ASSEMBLY FOR RADIATION DETECTOR TUBES OF VARIOUS SIZES AND SENSITIVITIES TO RADIATION. Natanagara, Hussein; Gotthoffer, Philip (to Trilobe Coupling Corp.). U. S. Patent 3,346,754. Mar. 26, 1964.

A mounting structure for radiation detector tubes of different sizes is described. It is composed of an external elongated mounting shell, two spaced insulator means mounted within said shell for holding a detector tube to be mounted within the shell, and a plurality of circumferentially spaced ribs forming an opening in the wall of the mounting shell between said insulator means and

extending substantially in longitudinal direction of said shell at acute angles with regard to lines parallel to the longitudinal axis of said shell to permit an incident radiation field to impinge upon a detector tube mounted within said shell without concealing entire radial sectors of the tube. (U.S. Pat. Gazette)

10572 NEUTRON DETECTOR. Andersson, Karl Osten INGVAR (to Aktiebolaget Atomenergi). British Patent 1,095,072. Dec. 13, 1967. Priority date Feb. 8, 1965, Sweden.

The design of a neutron detector for measuring neutron flux inside nuclear reactors is presented. The detector consists of a coaxial beta emitter and collector which produces a current proportional to the neutron flux. (W.H.K.)

10573 IMPROVEMENTS IN OR RELATING TO CIRCUIT ARRANGEMENTS FOR MEASURING THE AMPLITUDES OF A PULSE. (to Philips Electronic and Associated Industries Ltd.). British Patent 1,098,057. Jan. 3, 1968. Priority date Sept. 15, 1964, Netherlands.

A circuit for measuring pulses from a scintillation radiation detector is presented. The gating circuits, analog adder, comparator, and recorder are described. (W.H.K.)

10574 STUDY TO DETERMINE THE OPTIMUM PARAMETERS FOR A SCINTILLATION CAMERA. Scrimger, John William. Toronto, Univ. of Toronto, 1966.

Thesis.

A large thallium-activated sodium iodide scintillation camera which detects and displays radioisotope distribution is described. The system is designed for optimum performance. (TSS) (Diss. Abstr.)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 10502, 11950, 12127, and 12128.

10575 (CEA-B:b-110) LA SPECTROMETRIE GAMMA FINE PAR JONCTION P-i-N. APPLICATION A L'ANALYSE PAR ACTIVATION. (Fine Gamma Spectrometry Using P-i-N Junctions. Application to Activation Analysis). Sklavenitis, Laodamas (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 53p. (In French). Dep.

Thesis.

The author reviews the properties of solid detectors, their functioning and the various types existing at present. He describes further in more detail the gamma spectrometer using a lithium-drifted germanium detector and its applications in activation analysis. (auth)

10576 (CEA-R-3310) UTILISATION DU COMPTEUR PROPORTIONNEL A ^{3}He POUR LA SPECTROMETRIE DES NEUTRONS. (Use of the ^{3}He Proportional Counter for Neutron Spectrometry). Vialettes, Henry; Le Thanh, Phung (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1967. 52p. (In French). Dep.

The two methods which have been mainly used for neutron spectrometry near nuclear installations are photographic emulsion spectrometry and the so-called multisphere technique spectrometry. The first method has a threshold energy of about 500 keV; this is a big disadvantage for an apparatus which has to be used for spectrometry around nuclear installations where the neutron radiation is very much degraded energetically. The second method does not suffer from this disadvantage but the results which it yields are only approximate. In order to extend the energy range of the neutron spectra studied with sufficient accuracy, the use of a helium-3 proportional counter has been considered. This report presents the principles of operation of the helium-3 spectrometer, and the calculation methods which make it possible to take into account the two main effects tending to deform the spectra obtained which are energy absorption by the walls of the counter and energy loss of the incident neutrons due to elastic collisions with helium-3 nuclei. As an example of the application, the shape of the neutron spectrum emitted by a polonium–lithium source is given; the results obtained are in excellent agreement with theoretical predictions. (auth)

10577 (SGAE-PH-55/1967) SUMMIERENDES HALBLEITER-COMPTON-SPEKTROMETER. (Integrating Semiconductor Compton Spectrometer). Pepelnik, R.; Meyer, U.; Hick, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Physik-Institut). [1967]. 13p. (In German). Dep.

In a conventional semiconductor Compton spectrometer in which the energy of the Compton electrons is measured in a semiconductor detector, a linear broadening occurs through the motion of the bound electrons. The energy dependence of this effect was measured for Ge and Si in the energy range from 200 keV to 2.5 MeV. The first measurement results for a new type of summarizing Compton spectrometer with two Ge(Li) detectors show that interferring line broadening can be eliminated. (tr-auth)

10578 FAST–SLOW COINCIDENCE SCHEME FOR MEASUREMENT OF THE ANGULAR CORRELATION OF NUCLEAR EMISSIONS. Kosinov, G. A.; Kuyun, Yu. A.; Nemets, O. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 245-6(Feb. 1967). (In Russian).

A description is given of a fast-slow coincidence scheme in which the input signal is transformed into a bipolar equilibrium impulse, with time tie-in occurring when the impulse passes through zero. The coincidence scheme resolution time attainable without loss of effectiveness for input impulse amplitudes of 15 to 100 V is 25 nsec, with input frequency of 10^{5} impulse/sec^{-1}. The system does not require an input limiter. (JPRS)

10579 COMPARATIVE CHARACTERISTICS OF VARIABLE-FIELD MAGNETIC SPECTROMETER. Tarantin, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 247-51(Feb. 1967). (In Russian).

The parameters of uniform and nonuniform axisymmetric field magnetic spectrometers are considered from the viewpoint of combining the better dispersing capacity of the former with the simplicity and constant field topography of the latter. The particular case is reviewed of variable field spectrometer when the magnet pole terminals are in the form of parallel rings divided into several parts by triangular coutout segments with the vertices pointing inward. The necessary conditions for the exclusion of angular aberration and attainment of field reproducibility are stated. It is concluded that variable field spectrometers may have better characteristics at larger beam deflection angles. (JPRS)

10580 APPLICATION OF THE SUM-COINCIDENCE METHOD FOR g-FACTOR MEASUREMENTS OF SHORT-LIVED EXCITED NUCLEAR STATES. Bozek, E. (Inst. of Nuclear Physics, Krakow); Hrynkiewicz, A. Z.; Zapalski, G.; Kulessa, R.; Walus, W. Nucl. Instrum. Methods, 58: 325-6(Jan. 1968).

The application of the sum-coincidence technique in g-factor measurements by the observation of the integral angular correlation perturbed in an oriented magnetic field is discussed. The described method was used for the determination of the g-factor of the 603 keV state in ^{124}Te. (auth)

10581 SOME FIRST- AND SECOND-ORDER MAGNETIC OPTICS THEOREMS APPLICABLE TO THE DESIGN OF BEAM TRANSPORT SYSTEMS AND CHARGED PARTICLE SPECTROMETERS. Brown, K. L. (Varian Associates, Palo Alto, Calif. SLAC, Palo Alto, Calif.). pp 40-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The subject is treated under the following headings: Some useful first-order optical results derived from the general theory of beam transport optics (first-order dispersion, first-order path length, first-order imaging, magnification, first-order momentum resolution, zero dispersion, focal length, first-order matrix for ideal magnets, the R matrix transformed to the principal planes); and some general second-order theorems derived from the general theory (optical symmetries in n = ½ magnetic systems). (UK)

10582 COMPARISON OF THE PREDICTED AND ACHIEVED PERFORMANCE OF A LARGE SPECTROMETER MAGNET. Swales, F. J.; Reeve, P. A. (Rutherford High Energy Lab., Chilton, Eng.). pp 699-706 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Extensive and accurate measurements have been made of the main and fringe field distributions within the spectrometer, covering the whole available range of rigidities. The magnetic field as a function of radius was considered as a power series in polynomial form, and the measurements were made in a manner that enabled the polynomial coefficients to be calculated with a computer program. The optical performance of the spectrometer was calculated by the use of another computer program which uses a numerical technique for integrating the equations of motion; this was found to give accurate and reliable results when compared with experimental data. Results from the program indicate that the performance of the spectrometer should exceed the original specification where magnetic saturation effects can be ignored (up to about 12kG). Data are presented concerning a wide range of optical parameters, including shape, position and angle of the focal plane, momentum dispersion, resolution and solid angle. (auth)(UK)

10583 ELECTRON SPECTROMETERS USING A MAGNETIC CONDENSOR LENS. Falk, F.; Thun, J.-E.; Linnfors, A.; Siegbahn, K. (Univ. of Uppsala). Nucl. Instrum. Methods, 58: 181-200(Jan. 1968).

The behavior of a collimator lens for electrons is investigated. The electron emitting source is placed at the center of the lens where the maximum longitudinal field is 24kG. The action of this field is studied experimentally by means of a medium thick lens spectrometer, alternatively a semiconductor detector and photographic recordings. The effect of the magnet is to increase the transmission of the system. A transmission increase along the axis of 70 times is obtained. The electron trajectories and transmission effects are also studied theoretically by means of a computer. These results are consistent with the experiments and explain the behavior of the collimator. Some applications are discussed. It is suggested that a combination of the collimator and a high resolution, sector type double focussing instrument, may be used as well as a combination of the collimator with or without a magnetic spectrometer and a semiconductor detector for coincidence studies. (auth)

10584 A PLASTIC SCINTILLATION SPECTROMETER FOR ELECTRONS IN THE ENERGY RANGE 2 TO 20 MeV. Feist, H.; Harder, D.; Metzner, R. (Univ., Wuerzburg, Ger.). Nucl. Instrum. Methods, 58: 236-40(Jan. 1968). (In German).

The main advantage of plastic scintillators compared to anorganic phosphors in the spectroscopy of relativistic electrons is the reduction in bremsstrahlung escape from the scintillator. Energy calibration and experimental determination of the resolution matrix of a 6'' × 5'' dia. NE 102 A plastic scintillator have been performed using a beam of monoenergetic electrons from a betatron. Relative half-widths were 10% at 5 MeV and 5% at 20 MeV with axial incidence of the beam. Sufficiently small alterations of the resolution were obtained within certain ranges of displacement or inclination of the incident beam. Appropriate methods of calculating energy spectra from pulse height distributions are discussed. (auth)

10585 SOME HIGH-EFFICIENCY TWO-CRYSTAL Ge(Li)–NaI(Tl) PAIR SPECTROMETERS. Suominen, P.; Kantele, J. (Univ. of Helsinki). Nucl. Instrum. Methods, 58: 229-35(Jan. 1968).

Two types of two-crystal pair spectrometers employing Ge(Li) principal and NaI(Tl) auxiliary detectors are described. In one case, the germanium detector is surrounded by a 20 cm in dia. by 30 cm long optically uniform annular NaI(Tl) crystal coupled to seven photomultiplier tubes. An excellent line shape is obtained by operating the photomultipliers in a special way making use of the fact that light distributions following the absorption of Compton and annihilation quanta are different. In another pair spectrometer, which is essentially simpler, a small annular crystal detects the annihilation quanta emitted from the main crystal in backward directions. The intrinsic peak efficiencies of both spectrometers are almost 20% of the intrinsic double-escape peak efficiency of the germanium detector. (auth)

10586 NEUTRON SPIN-FLIP CHOPPER. Rauch, H.; Harms, J.; Moldaschl, H. (Atominstitut der Oesterreichischen Hochschule, Vienna). Nucl. Instrum. Methods, 58: 261-8 (Jan. 1968). (In German).

A method for generating neutron packs by means of a chopped spin-flip-device in connection with a polarized-neutron spectrometer is described. The duration and the repetition rate of the neutron-packs can be determined over a wide range electronically. The resolution $\Delta t/t$ or $\Delta\lambda/\lambda$ is 3.3% and may be improved without any loss of intensity to better than 1%. For repetition rates higher than 5000 c/s, the peak intensity is higher than the peak intensity obtained with comparable mechanical two-chopper-systems. The described method is specially suited for measuring small changes of neutron energy. (auth)

10587 A POST-FOCUSING ACCELERATOR FOR A $\pi\sqrt{2}$ SPECTROMETER. Krisciokaitis, R. J.; Haynes, S. K. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 58: 309-14(Jan. 1968).

A post-focusing accelerator for a $\pi\sqrt{2}$ spectrometer is described which enables electrons down to less than 150 eV to be detected quantitatively with almost negligible spurious background. The properties of the accelerator are illustrated with K- and L-Auger lines of ^{115}In from ^{113}Sn. (auth)

10588 SATELLITE PULSES FROM PHILIPS 58 AVP PHOTOMULTIPLIER AND THEIR EFFECT ON (γ,n) TIME-OF-FLIGHT SPECTROSCOPY. Shin, Y. M.; Ku, S. H.; Glavina, C.; Rawlins, J. A. (Univ. of Saskatchewan, Saskatoon). Nucl. Instrum. Methods, 58: 353-5(Jan. 1968).

The current and time distribution of satellite pulses from the Philips 58 AVP photomultiplier have been measured. The influence of the satellite pulses on neutron time-of-flight spectra from the photodisintegration of nuclei is discussed. (auth)

10589 EFFICIENCIES OF A COINCIDENCE SPECTROMETER FOR POSITRON ANNIHILATION RADIATION. ADDENUM. Verheijke, M. L. (Philips Research Labs., Eindhoven, Netherlands). Nucl. Instrum. Methods, 58: 347-8(Jan. 1968).

Calculated efficiencies are given for the case where the two NaI(Tl)-crystals are placed with the axes parallel. This arrangement may be attractive in order to save space when a sample changer has to be used. (auth)

10590 NEW TYPE OF INTERNAL PAIR FORMATION SPECTROMETER. Michaelis, W.; Lange, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 58: 349-50 (Jan. 1968).

A new type of internal pair formation spectrometer is described which makes use of the high resolution capabilities of semiconductor diodes. The instrument consists of two silicon detectors forming a dE/dx + E telescope for the positron-electron pair and two NaI(Tl) scintillation counters for detecting the positron annihilation quanta. With present techniques the optimum energy resolution is 0.07% at 10 MeV. The instrument has been designed for applications in neutron capture spectroscopy. (auth)

10591 PULSE SHAPE DISCRIMINATOR FOR THE FAST NEUTRON TIME-OF-FLIGHT-SPECTROMETER. Akiyoshi, Tsunekazu (Kyoto Univ.); Sonoda, Masateru. Kyushu Daigaku Kogaku Shuho, 39: 21-5(May 1966). (In Japanese).

The difficulty involved in the discrimination of pulse shapes of background gamma rays in fast-neutron measurements with an organic scintillator is discussed. A fast neutron time-of-flight spectrometer was previously constructed. An attempt was made to perform experiments on the inelastic scattering of 14-MeV neutrons by heavy nuclei, in which case, it became necessary to eliminate the intense gamma ray background. Considerable improvement of the spectrometer was achieved by constructing an Owen-type pulse-shape discriminator with Ne 213 liquid scintillator; the results of its test are described. Satisfactory results were obtained from the inelastic scattering experiments with some heavy nuclei, such as Bi, Pb, Tl, Hg, Au, W, and Ta. Since the neutrons scattered in the laboratory also enter the apparatus, it was necessary to shield the neutron detector with paraffin or lead blocks, so that the background due to them may be minimized. (NSA of Japan)

10592 METHODS OF ALPHA SPECTROMETRY. Flakus, F. N. (Technische Hochschule, Munich). Kerntechnik, 9: 513-15(Nov. 1967). (In German).

The most important methods of alpha spectrometry are summarized, and a comparison is made concerning especially their energy resolution. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 11284, 11575, 11607, and 11822–11825.

10593 (CERN-67-31) A DATA LINK BETWEEN TWO COMPUTERS; DEVELOPMENT OF SOFTWARE AND EXPERIENCE OF ITS USE WITH A MISSING-MASS SPECTROMETER EXPERIMENT. Bell, T. R.; Levrat, B. C.; Marcer, P. J.; Palandri, E. M. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 21, 1967. 31p. Dep.

Data from a missing-mass spectrometer experiment, collected and prechecked on an SDS 920, was transmitted via data-link to the CERN central computing facilities where it was processed on-line within the environment of the SIPROS multiprogramming operating system of the CDC 6600. The software developed for the initial production runs is described, together with the experience obtained. (auth)

10594 (IA-1131) THE CYLINDRICAL CAPACITOR AS AN ANALYZER. II. RELATIVISTIC PART. Sar-El, H. Z. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Oct. 1967. 31p. Dep.

The study of the dynamic and optical properties of the cylindrical capacitor as an analyzer for charged particles is extended to the relativistic region. The proposed analyzer is found to be absolutely unrestricted by the relativistic effect, the latter introducing some changes which do not however impair the analytical features of the device. The emission angle for which there is a second order focus is energy-dependent, shifting from $\theta_0 = 42°18.5'$ in the nonrelativistic case to $\theta_0 = 55°$ in the ultrarelativistic case. It is shown that the usual derivation of the relativistic formulae from the nonrelativistic ones by replacing the nonrelativistic potential difference by an effective relativistic potential differ-

ence is incorrect for electrostatic devices, unless this quantity is given a specifically electrostatic form, distinct from the magnetic one. The figures of merit of the analyzer concerning resolution and luminosity are comparable with those of the best magnetic spectrometers. The analyzer seems to be simpler and cheaper than the magnetic type, but calls for very high deflecting voltages, which may be a disadvantage in operation. (auth)

10595 (SLAC-PUB-358) A PICTURE CALCULUS. Miller, W. F.; Shaw, Alan C. (Stanford Univ., Calif.). Oct. 1967. Contract AT(04-3)-515. 16p. (CONF-671126-1). Dep. CFSTI.

From Conference on Emerging Concepts in Computer Graphics, Urbana, Ill.

Development of a picture calculus for computers, comprised of a picture description language (PDL), rules for transforming and comparing structures represented in PDL, data structures and control for generation of pictures, and the parsing and primitive recognizers needed for picture recognition, is discussed. Line drawings, flow charts, block letters, printed pages, particle physics pictures, and closed boundary curves can be meaningfully described in PDL. (W.H.R.)

10596 (TID-24218) SPARK CHAMBERS USING HIGH-DENSITY MEDIA. Reibel, K. (Argonne National Lab., Ill.); Schluter, R. A. (Argonne National Lab., Ill. Northwestern Univ. [Evanston, Ill.]). Mar. 7, 1963. 16p. Dep. CFSTI.

Two attempts at operating spark chambers in media of higher than usual densities are described. The first attempt, using liquid helium, was unsuccessful. The second attempt made use of argon at a density of 0.015 gm/cm^3 and proved the feasibility of a high resolution chamber by producing sharp sparks with high efficiency. (W.H.K.)

10597 (UCRL-17918) COMPUTER DATA LINK FOR HIGH-ENERGY PHYSICS EXPERIMENTS. Andreae, Sypko W. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 6, 1967. Contract W-7405-eng-48. 9p. (CONF-671123-1). Dep. CFSTI.

From Fall Digital Equipment Computer Users' Society Symposium, Anaheim, Calif.

At LRL small computers are used on-line with high-energy physics experiments. When the experimenter desires to estimate the relative value of the experimental data, the necessary analysis can only be performed on a large computer. Hence the need arose for a fast two-way data link between one or more small computers and a large computer. The lack of interrupt facilities in the available large computer and the necessity of using twisted-pair telephone lines both posed unusual design problems. The main components of the Data Link are interfaces for the two computers, a buffering and error-correcting system, and a transceiver system using 1-mile-long telephone lines. A unique demand and response system both maintains synchronization and supports a highly accurate error-correction system. Control words communicate word count, transfer direction, etc., between the computer programs. Special high-reliability pulse-train signals transmit critical information, such as error and end of record between the interfaces. (auth)

10598 TELEVISION MEASURING PROJECTOR FOR BUBBLE CHAMBER PHOTOGRAPHS. Birk, M.; Brafman, H.; Feldman, H.; Jacob, A.; Leboy, E. L.; Nunamaker, T.; Sokolowski, J.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel). Nucl. Instrum. Methods, 58: 282-8(Jan. 1968).

An instrument employing closed-circuit television for the measurement of coordinates and bubble density of charged particle tracks in bubble chamber photographs is described. The instrument uses a Moiré fringe image plane digitizer. With the aid of servo-motors, a vidicon camera can be moved in the X and Y directions and can also be rotated. Once set on the proper track by the operator, the vidicon follows the track in a staggered motion. At each stop, the machine automatically punches out onto IBM cards the X and Y coordinates of the center of the track and also the total length of the gaps and the number of gaps in the segment. The least count in the image plane is 10 μm. Ionization measurement reproducibility checks gave a standard deviation of ±3%. In an actual experiment, the rms deviation of the measured ionization from that calculated from the kinematics was less than ±14%, and the measuring rate was 4 events/h. (auth)

10599 SIMPLE TRAP FOR HIGH PRESSURE GAS TARGETS. Mancusi, M. D.; Jones, C. M. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 58: 351-2(Jan. 1968).

A combined pump and trap is described which is capable of removing condensable impurities from high pressure gas targets. (auth)

10600 REPORT ON THE ARGONNE NATIONAL LABORATORY 12-ft HYDROGEN BUBBLE CHAMBER MAGNET SYSTEM. Purcell, J. R. (Argonne National Lab., Ill.). pp 560-3 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The magnet system is designed to provide an 18 kilogauss field for a liquid hydrogen bubble chamber. The bubble chamber is a cylinder with a nominal diameter of 12 ft and a visible volume of ~20,000 liters. The inside diameter of the windings is 16 ft and the distance between pole faces is 10 ft. Sixteen hundred tons of iron will be used for the return path. The coil design utilizes a face-cooled wafer construction wound with strip type conductor, which is completely stable and requires no additional reinforcing material. (auth) (UK)

10601 DESIGN OF A 1.3m INNER DIAMETER 50kG SUPERCONDUCTING BUBBLE CHAMBER MAGNET SYSTEM. Benz, H.; Lutz, H. (Oerlikon Engineering Co., Zurich). pp 564-73 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

A preliminary cost optimization showed that a magnet of this type should be constructed with a massive iron circuit. The design parameters of the magnet were determined after investigating the distribution of the magnetic field and the electromagnetic forces, as well as the effect of the iron yoke on the centre field, on the homogeneity and on the leakage field. For these digital computations the nonlinear B(H)-curve of the iron and the nonlinear I_c-H_c characteristic of the superconductor were taken into account. Calculation of the electromagnetic forces and mechanical stresses inside the coil cross-section led to the choice of a stabilized composite superconductor with antimagnetic steel reinforcement. Dewar was designed to meet the requirements of thermal insulation, current leads and mechanical supports, after calculation of heat leaks and the effect of radial and axial displacements of the coil pair relative to the iron yoke. A short account is given of general cooling considerations and of design principles for the refrigerator. With relation to the magnet power supply, some problems such as stabilization and regulating transients are briefly mentioned. (auth) (UK)

10602 400-KILOJOULE SUPERCONDUCTING MAGNET FOR A POLARIZED TARGET EXPERIMENT. Desportes, H. (CEN, Saclay, France). pp 603-10 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The results obtained with the magnet described in this paper have demonstrated that semi-stabilized conductors can perform satisfactorily in magnets of the size necessary for many high energy physics experiments. The advantages of such conductors are that they do not excessively increase the weight and size of the apparatus, and that they allow relatively high average current densities (6000 to 8000 A/cm^2). Such advantages will present special interest in the case of bending magnets and quadrupoles, for which the price depends considerably on the current density. Tests have shown the conductor to have a stability level sensibly higher than the current carrying capacity predicted by the full stabilization criteria usually considered. The quenching phenomenon, which exists in magnets of this type, can overcome the self-protection limit of the cable when the stored energy exceeds 200 kilojoules, but the consequent risk of damage can be easily eliminated by means of adequate external protection. (auth) (UK)

10603 PERFORMANCE OF THE MAGNET FOR THE OXFORD-RUTHERFORD LABORATORY 80cm HELIUM BUBBLE CHAMBER. Peel, T. D. (Oxford Univ.); Roaf, D.; Shaw, D. F.; Turner, W.; Weeks, G. C.; Hadley, H.; Seager, P. pp 722-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The magnet has been commissioned and used successfully during a test run of the bubble chamber with a beam of negative pions of 1.5 GeV/c momentum. Since the pancake coils were smaller than originally designed, it was possible to add more iron to the inside of the yoke, with a resultant increase in field by about 5%. The determination of the momentum of charged particles from the curvature of the track image is greatly facilitated if the magnetic field is known accurately in analytical form as a simple function of position in the bubble chamber. Track distortion and multiple scattering limit the accuracy of momentum measurement, and the accuracy required for the magnetic field data may be matched to these other sources of error. In practice errors

in field values up to one-half percent are generally negligible. (auth) (UK)

10604 SCANNING APPARATUS FOR AIDING IN THE DETERMINATION OF POINT CO-ORDINATES OF PATHS OF CHARGED PARTICLES AS RECORDED ON PHOTOGRAPHIC FILM. Alvarez, Luis W. (to United States Atomic Energy Commission). U. S. Patent 3,366,794. Jan. 30, 1968.

A high-speed film scanning device for bubble chamber data analysis which operates on-line with a computer for immediate bubble track measurement and particle event verification is described. A rotating drum circulates a periscoped image of the film portion within the scanning aperture over a surface containing a gridwork of light-sensitive benchmarks. Upon coincidence of a film bubble on a benchmark, the combined data of the translational position of the real aperture, the rotational position of the image aperture, and the known location of the benchmark is operated on by the computer and immediately indicates the bubble position with respect to the major fiducial points of the film. (AEC)

10605 OPTICAL SCANNING BACKGROUND DENSITY NORMALIZER. Russell, Jerome A. G.; Neu, Franklin D. (to United States Atomic Energy Commission). U. S. Patent 3,361,029. Jan. 2, 1968.

Optical scanning devices which detect nuclear particle tracks recorded on photographic film and provide automatic means for distinguishing the tracks from other extraneous patterns present in the film are described. Two photomultiplier tubes simultaneously scan the film; the first tube responds to intensity variations in a minute area of the image while the second tube acts as a background scanner viewing a larger area and responds to the average image intensity immediately surrounding and including the point viewed by the first tube. The outputs of the two photomultiplier tubes are continuously compared in a difference amplifier whereby the tracks of interest are detected by a sharp signal contrast therebetween and are indicated by a corresponding change in the output from the amplifier. (AEC)

10606 VARIABLE RADIATION LENGTH BUBBLE CHAMBER. Goldhaber, Maurice (to U. S. Atomic Energy Commission). U. S. Patent 3,358,143. Oct. 13, 1966.

A method of operating a hydrogen bubble chamber consisting of means forming a sealed chamber and means for selectively varying the volume of the space within the chamber is described. Preselected amounts of liquid hydrogen are added to the chamber, and a preselected amount of liquid neon is added to establish a desired radiation length for the bubble chamber. The hydrogen–neon mixture is cyclically compressed and expanded to render it sensitive to ionizing radiation. (U.S. Pat. Gazette)

10607 ISKROVAYA KAMERA. (Spark Chamber). Daion, M. I.; Dolgoshein, B. A.; Efremenkv, V. I.; Leksin, G. A.; Lyubimov, V. A. Moscow, Atomizdat, 1967. 319p.

A new spark chamber for recording charged particles is described. The spark chambers perform as efficient particle track detectors. The development of electric discharge in gases, general characteristics of spare counters, gas discharge pulse hodoscopes, construction and performance of air-spark chamber and ordinary spark chambers are discussed as well as spark chambers with large gaps and chambers with localized discharges on the particle track. The problems of spark chamber supply systems and data information reading are also discussed. (R.V.J.)

10608 RE-EVAPORATION NUCLEI AND EVAPORATION IN A WILSON CLOUD CHAMBER. Smith, James Gilbert. Rolla, Mo., Univ. of Missouri, 1967. 129p.
Thesis.

Experimental techniques are developed for observing droplet evaporation in the submicroscopic size range. An expansion-compression cloud chamber with an atmosphere of tank helium saturated with water vapor is employed. This work was undertaken with the aim of examining submicroscopic droplet behavior and the existence of re-evaporation nuclei. The theories of evaporation and nucleation on submicroscopic drop residues were re-examined, and alterations which appear to be consistent with the results of this work were incorporated into the evaporation theory. (TSS) (Diss. Abstr.)

Radiation Dosimeters

Refer also to abstracts 10282, 10667, 10774, 10777, and 12110.

10609 (IDO–12056) A GENERAL SUMMARY OF PERSONNEL MONITORING SYSTEMS UTILIZED AT THE NATIONAL REACTOR TESTING STATION. Cipperley, Foster V. (Idaho Operations Office (AEC), Idaho Falls. Health and Safety Div.). Sept. 1966. 30p. Dep. CFSTI.

A summary of personnel monitoring systems utilized at the National Reactor Testing Station is presented as a guide to the establishment or updating of personnel monitoring programs. Descriptions of the various devices and equipment used in the detection and measurement of radiation are presented, as well as procedures for energy and dose determinations applicable to the particular badge used at the NRTS. A personnel neutron threshold detector and a primary nuclear accident dosimeter unit for the determination of neutron dose resulting from a criticality incident or other massive neutron exposure are described. A brief description of the newly designed solid-state dosimetry system and the method of its implementation is also presented. A method for handling visitors and other temporary-type coverage is described which has affected a savings of some 50% in the handling of temporary-type exposure records. A rather detailed description of a punched-card record keeping system is provided. (auth)

10610 (ORO–2036-3) PHYSICS OF THE PHOTOGRAPHIC PROCESS. Slifkin, Lawrence (North Carolina Univ., Chapel Hill). Sept. 1967. Contract AT(40-1)-2036. 24p. Dep. CFSTI.

A summary of the current understanding of the physical phenomena of the photographic process is presented. Topics discussed include electron band structure of silver bromide and chloride, formation of the latent image, electrons and holes, reciprocity failure and the latent image, latent image regression effects, sensitization, and high energy radiation and particles. (W.H.K.)

10611 ALL-STATE FILM DOSIMETRY SERVICE IN CSSR. PART III. THE EVALUATION OF HIGH-LEVEL DOSES, MEASURING ERRORS, AND ORGANIZATION OF SERVICE. Trousil, Jaroslav; Bucina, Ivan (Inst. for Research, Production, and Application of Radioisotopes, Prague). Jad. Energ., 13: 454-62(1967). (In Czech).

A statistical evaluation of maximum errors which occur in film dosimetry with respect to dose and the photographic films available is presented. The criteria for choosing films sensitive to gamma, beta, and x radiation at 20 mR to 1000 R with an accuracy better than ±30% and at 50 mR to 600 R with an accuracy better than ±20% are discussed. The method of high level dose evaluation using emulsions with low sensitivity and inhibitors of developing processes is described. The organization for film dosimeter service in CSSR is examined. (auth)

10612 RADIATION QUALITY EFFECTS IN CHEMICAL DOSIMETRY. Faw, R. E.; Donnert, H. J. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods, 58: 307-8(Jan. 1968).

An examination has been made of the importance of the effects of secondary electrons in the interpretation of yields of the Fricke dosimeter for high energy charged particles. (auth)

10613 FOURIER ANALYSIS OF THE BLURRING CAUSED BY THE IONIZATION CHAMBER. I. IN AIR DOSIMETRY. Uchida, Suguru (Osaka Univ.). Jap. J. Appl. Phys., 7: 90-1 (1968).

The blurring caused by a 4 mm diameter ionization chamber in air dosimetry is analyzed in the spatial frequency domain. The real dose distributions of the field are evaluated by inverse Fourier transforms. (W.H.K.)

10614 FOURIER ANALYSIS OF THE BLURRING CAUSED BY THE IONIZATION CHAMBER. II. IN DEPTH DOSIMETRY. Uchida, Suguru (Osaka Univ.). Jap. J. Appl. Phys., 7: 91-2 (1968).

The blurring effects of ionization chamber size on depth dosimetry are treated. The real dose distributions of the field are evaluated by inverse Fourier transforms. (W.H.K.)

Radiometric Instruments

Refer also to abstract 10779.

10615 (IFA-IS–45) INSTALLATION POUR LA DETECTION AUTOMATIQUE DE LA CONTAMINATION RADIOACTIVE DE L'EAU POTABLE ET DES EAUX RESIDUELLES. (Installation for Automatic Detection of Radioactive Contamination of Drinking Water and Waste Waters). Szabo, Arpad; Bratu, C.; Mathe, T.; Bossanyi, A. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1967. 9p. Dep.

An automatic radiometric installation is described. With the installation, the drinking water source of a community can be automatically assured against accidental contamination. It will signal the contamination of residual waters which flow into natural water basins. The apparatus can be mounted at the reservoirs of the pumping stations. The variations in the radiation intensity of the controlled waters are detected by a battery

of G–M counters installed in series. The relays act in the moment at which the radiation intensity of the water exceeds a certain pre-established threshold value. The current pulse after integration and amplification controls the action of an electromechanical relay which permits sound signals and the automatic closing by servomotors of the water main if radioactive contamination of the water of the collector basin appears. The electric current supply of the apparatus is made with a transformer in ferro-resonant stabilization regime. The high voltage is assured by a stabilizer tube with corona effect. (tr-auth)

10616 X-RAY ANALYSIS OF THIN FILMS BY PROTON BOMBARDMENT. Sterk, A. A.; Saylor, W. P.; Marks, C. L. (American Machine and Foundry Co., Alexandria, Va.). Norelco Rep., 14: 99-102(July-Dec. 1967).

Thin-film thickness measurements by proton and/or positive ion bombardment are discussed and data are presented establishing the sensitivity of the method for the measurement of thin films ranging in thickness from several thousand angstroms to a few monolayers. The lower limit to thickness measurement was controlled by the magnitude of the x-ray generation cross sections and the counter sensitivity, and the upper limit by the energy of the bombarding ions. A special nondispersive detection technique was developed for the analysis of trace amounts of oxygen. The method is based on selective x-ray filtering with pure oxygen as the main absorbing element. Characteristic x-ray emission lines created as a result of proton excitation of a target were applied to the study of thin films of oxygen and thin deposits. (BBB)

10617 MOISTURE-DETECTION EFFICIENCY AND GEOMETRY OF β-RAY MEASUREMENTS. Hattori, T. (Muroran Inst. of Tech., Japan). Elec. Eng. Jap. (Engl. Transl.), 87: 1-11(1967).

The Monte Carlo calculations were made and fundamental experiments conducted with a β-ray measuring system with the collimator at the source side. When the collimator was installed at the source side, the counting rates were calculated for each sample position with respect to each energy level of the emitted electrons using the Monte Carlo method and a computer. The calculated results were compared with that obtained by the conventional approximated equation. The results approached the experimental data when the back-scattering effect from the inner wall of collimator was corrected for. The sample position vs the counting rate curve depended considerably on the dia of the collimator hole. It was found that there was an optimal hole, at which the counting rate became approximately constant regardless of the sample position. It was possible to reduce the counting error due to the variation of the sample position by choosing the optimal dia in consecutive measurements. If the sample was placed close to the source, the collimator reduced the count rate considerably. As the collimator-hole dia decreased, this affected the count rate of the sample located far from the source. (BBB)

10618 NEUTRON DETECTION SYSTEM. Ind. Electron., 5: 350(Aug. 1967).

The UK Atomic Energy Authority has developed a neutron detection system, for use in neutron radiography, which will give a permanent visual image of the shadows cast when neutrons are passed through a solid object; it will thus provide a useful method of examining materials and components. The system is similar in principle to that of xerography, except that the electrostatic charge is formed in a different way, and comprises two parallel Al plates (separated by a narrow air gap), the adjacent surfaces of which carry layers of Se and Li respectively. Prior to use, a uniformly-distributed electrostatic charge is created on the surface of the Se layer and the Al plate carrying this layer, and the Al plate carrying this layer is grounded. When a beam of neutrons reaches the Li layer, charged particles are emitted, some of which pass into the Se layer; the surface of this layer thus acquires a pattern of charge corresponding to the spatial distribution of the neutrons passing through the object being radiographed. After exposure, the Li-covered plate is removed, and a powder (formed by particles of pigment carrying an electrostatic charge of opposite sign to that on the surface of the Se layer) is dusted on to the Se layer; these particles adhere preferentially to the pattern of charge on the surface of the Se layer and so reproduce this pattern in pigment. A sheet of paper or other suitable base material is then laid on the surface of the Se layer and is given an electrostatic charge of the same sign as the initial charge on the Se layer. The pigment is thus transferred to the paper and can be fixed and made permanent by heating. (BBB)

10619 METHOD AND APPARATUS FOR RADIATION DIRECTION FINDING. Tolmie, R. W. (to Atomic Energy of Canada Ltd.). Canadian Patent 763,531. July 18, 1967.

The radioactive radiation emission is divided into two zones by placing a shield between a pair of counting tubes. By changing the orientation of the device a different output voltage is obtained from one tube indicating greater radiation in that zone. An electric signal whose polarity is indicative of the zone having the higher count rate is displayed by a needle. The plane of division is rotated until the signal shows that the plane and the direction of emission are in alignment. Medical uses, prospecting and locating pipes in walls by the principle of reflection are suggested. (F.S.A.)

10620 MOISTURE GAUGING SYSTEM. (to Republic Steel Corp.). British Patent 1,092,956. Nov. 29, 1967. Priority date Jan. 8, 1964, United States.

The design of a radiometric moisture gaging system for solids as they are transported on a conveyer belt is described. Fast neutron and gamma sources are used with a slow-neutron detection system and a gamma detection system. Specifications of the electronic circuitry used are presented. (W.H.K.)

10621 DEVICE FOR INDICATING THE DEGREE OF EXHAUSTION OF AN EXHAUSTING WALL. Iwai, Masaru (to Mitsubishi Electric Corp.). Japanese Patent 1966-13001. July 22, 1966. Filed July 31, 1963.

The device proposed is used for exhaust walls such as that of melting furnaces; the inside of such a wall is eroded as the furnace is used. The device consists of the following: array of radiation sources which are embedded within the wall; a radiation detector, movable along the wall circumference; and the erosion indicator, which indicates the degree of erosion by means of the radiation value detected by the radiation detector. (NSA of Japan)

10622 APPARATUS FOR GAS ANALYSIS HAVING VOLTAGE MEANS TO ACCELERATE ELECTRONS FROM AN IONIZATION CHAMBER TO A DETECTION CHAMBER. Gregory, Norman Lennox (to National Research Development Corp.). U. S. Patent 3,361,907. Dec. 2, 1963. Priority date Dec. 6, 1962, Great Britain.

An apparatus for detecting a gaseous component in a mixture with at least one other gaseous component is described. It is composed of a detector enclosure and an auxiliary enclosure which communicates with the detector enclosure, inlet and outlet means for the detector enclosure whereby a gaseous stream may be passed through the detector enclosure without passing through the auxiliary enclosure, further inlet means for the auxiliary enclosure whereby a further gaseous stream may be passed into the auxiliary enclosure and thence into the detector enclosure, detector means for responding to the presence of said gaseous component in the detector enclosure, and a radio-active source disposed within the auxiliary enclosure, and including a means for establishing an electric potential between said detector enclosure and said auxiliary enclosure for accelerating electrons from the auxiliary enclosure to the detector enclosure. (U. S. Pat. Gazette)

10623 SYSTEM FOR MEASURING THE MASS OF MATERIAL BY THE DETECTION OF RADIATION SCATTERED BY THE MATERIAL. Kowalczynski, Jerzy Klemena U. S. Patent 3,361,911. Apr. 22, 1963. Priority date Apr. 27, 1962, Poland.

A radiometric system for measuring the mass of a stream of material moving in a given lengthwise direction generally in a plane and having a substantial width in the plane perpendicular to the lengthwise direction of its movement is described. The system is composed of a radiation source at one side of said plane of movement of the material and extending across substantially the full width of said stream and producing radiation which impinges on said material across said full width of said stream throughout a substantial dimension thereof in said lengthwise direction; a radiation detector at the opposite side of said plane of movement of the material extending across substantially the full width of said stream; and a radiation shield extending across substantially the full width of said stream between said radiation source and said radiation detector and operative to substantially and completely absorb all primary radiation passing from said source directly through said material at either side of said shield in said lengthwise direction. (U. S. Pat. Gazette)

10624 MONITORING DEVICES INDICATING SPACING BETWEEN ARTICLES MOVING IN A STREAM. Muir, Douglas William Ballantyne (to Molins Organisation Ltd.). U. S. Patent 3,355,592. May 22, 1964. Priority date May 23, 1963, Great Britain.

A monitoring device for use in checking spacing between successive articles in a continuous stream along a defined path is described. It is composed of means located on one side of said said path for projecting a beam of radiation across said path, radiation-sensitive detector means arranged on the other side of said path to receive said beam, and ac circuit means connected to receive an electrical output from said detector means, said beam and said detector means being placed at a single station along said stream so that the beam is interrupted by

articles passing in said stream delivering an electrical output pulse whenever said beam is received at a gap between two successive passing articles, so as to produce a succession of electrical pulses of uniform amplitude but of duration dependent upon the lengths of gaps between successive articles, and said ac circuit means comprises direct current blocking means sensitive to the average amplitude value over a period of time of said succession of output pulses for limiting transmission of a control signal to such times as the average amplitude value is within a preselected range. (U. S. Pat. Gazette)

Miscellaneous Instruments and Components

Refer also to abstracts 10821 and 11557.

10625 (ANL–7257) A HIGH-TEMPERATURE, CONTROLLED-ATMOSPHERE X-RAY DIFFRACTOMETER ATTACHMENT. Maurer, J. H.; Ackermann, R. J. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

The design of an attachment to be used with a Norelco Wide Range Goniometer at controlled atmospheres at temperatures up to 2500°C is presented. The attachment is designed to maintain precise specimen alignment over broad temperature ranges and simultaneous precise control of known temperatures and compositions of the specimens. (W.H.K.)

10626 (CEA-R–3268) DISPOSITIF D'ASSERVISSEMENT EN POSITION DES FAISCEAUX D'IONS DANS UN SPECTROMETRE DE MASSE. (Position Control Mechanism for Ion Beams in a Mass Spectrometer). Boyer, Robert (Commissariat a l'Energie Atomique, Pierrelatte (France)). Sept. 1967. 42p. (In French). Dep.

An original procedure is described which allows to control very accurately the ion beams position in mass spectrometers used for isotopic analysis with dual collection. The stability value obtained is a value for the stability of the accelerating voltage or the analyzing magnetic field of the order of 10^{-6} (relative value). This procedure has the advantage of multiplying by ten the useful reading time for isotopic yields and in principle thus increasing the precision of enrichment measurements. (auth)

10627 (CEA-R–3368) MESURE DE LA PUISSANCE ET DE LA PERIODE D'UN REACTEUR NUCLEAIRE A L'AIDE D'UNE CHAINE SIMULTANEMENT LINEAIRE ET LOGARITHMIQUE. (Measurement of the Power and of the Period of a Nuclear Reactor Using a Simultaneously Linear and Logarithmic Channel). Feghahati, Emad-ed-din (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 11p. (In French). Dep.

A simultaneously logarithmic and linear channel for measuring the power of a nuclear reactor using a single detector has been developed. It consists of a linear element and of a logarithmic element in the counter-reaction circuit of the measurement amplifier. The operation of this channel appears to be perfectly satisfactory. It can be connected to a period meter. The range of the logarithmic measurement extends from 10^{-10} to 10^{-4} A and that of the linear measurement from 10^{-9} to 10^{-3} A. It will be possible to extend the linear measurement to 10^{-10} A. (auth)

10628 (IFVE-SEF-67-2-k) PYATILUCHESOI OSTSILLOGRAF DLYA IZMERENIYA VREMENI ZHIZNI π^+-MEZONA. (A Five-Ray Oscilloscope for Measuring π^+-Meson Lifetime). Dunaitsev, A. F.; Simonov, Yu. N. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. 14p. (In Russian). Dep.

A five-ray oscilloscope is described for photoregistration of pulses from counters with their subsequent amplitude and time analysis. The device allows one to have, at the same time, sweep rates from 10 to 80 ns/cm for three rays and from 0.5 up to 10 μs/cm for the remaining two rays. The linearity of the sweep is better than 0.5 and 1%, respectively. (auth)

10629 (IFVE-SEF–67-12-k) SINKHRONIZATOR DLYA ZADERZHANNOGO ZAPUSKA RAZVERTKI OSTSILLOGRAFA OT IMPUL'SOV ISSLEDUEMYKH SERII. (A Synchronizer for Delayed Trigger of the Oscilloscope Sweep From the Pulses of the Series Under Investigation). Vishnevskii, N. K.; Rykalin, V. I.; Khromov, V. P. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. 10p. (In Russian). Dep.

To investigate long series of nanosecond pulses a delayed trigger circuit of the oscilloscope sweep is developed. The sweep pulses are tied to those of the series under investigation with an accuracy of less than 0.5 ns. The circuit allows one to observe any part of the series with the pulse duration up to the tenths of a second, the sweep rate being less than 10 ns/cm without a diffuse image. The circuit operates stably at a repetition frequency inside a series of more than 100 MHz. (auth)

10630 (LRP–34 /67) OSCILLOSCOPE A 12 VOIES VERTICALES. (A Twelve Channel Oscilloscope). Perotti, J.-P. (Laboratoire de Recherches sur la Physique des Plasmas, Lausanne (Switzerland). Dec. 1967. 31p. (In French). Dep.

A 12-beam oscilloscope is described. The Y amplifiers, the response of which extends from 10 c/s to 25 Mc/s and the sensitivity from 50 mV to 5 V/cm, are transistorized. The power consumption, 1 kW, is reasonably low. The sweep rates range from 0.1 to 500 μsec/cm. (auth)

10631 (NAA-SR-Memo–12582) LIQUID METAL LEVEL MEASUREMENT (SODIUM) STATE-OF-THE-ART-STUDY. Slocomb, H. W. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Nov. 15, 1967. Contract AT(04-3)-700. 34p. Dep. CFSTI.

Level measuring devices for liquid metal systems and characteristics of the measuring techniques are outlined. Discussed are the point contact, the resistance tube, and various forms of inductive sensors. Other techniques described include pressure transducers, surface float, displacement float, ultrasonic, pulse delay line, and microwave cavity. (W.H.K.)

10632 (NYO–3622-12) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 37, October 1–November 30, 1967. (Aeroprojects, Inc., West Chester, Pa.). Dec. 1967. Contract AT(30-1)-3622. 9p. Dep. CFSTI.

Modification of the incipient boiling test loop at Mine Safety Appliance Research Corporation (MSAR) has been completed and tests are scheduled for early December. Scale-up of the flowmeter loop has begun and data now available from runs at the higher flow rates are given. Preparations for molten sodium calibration of an ultrasonic flowmeter have been initiated. (auth)

10633 (ORNL–4143) THE OAK RIDGE COMPUTER-CONTROLLED X-RAY DIFFRACTOMETER. Busing, W. R.; Ellison, R. D.; Levy, H. A.; King, S. P.; Roseberry, R. T. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 259p. Dep. CFSTI.

The Oak Ridge computer-controlled x-ray diffractometer consists of a Picker four-circle diffractometer interfaced to a Digital Equipment Corporation PDP-5 computer. A system of programs has been developed which facilitates the collection of three-dimensional single-crystal intensity data. This report includes detailed instructions for using the instrument, a description of the interface hardware and software, and a complete listing of the computer programs. (auth)

10634 (RISO–M–626) BERETNING OM ARBEJDET I ELEKTRONIKAFDELINGEN I TIDEN 1. APRIL TIL 30. JUNI 1967. ([Electronics]. Quarterly Report for the Period April 1–June 30, 1967). (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1967. 31p. (In Danish). (R–17-67). Dep. CFSTI.

A summary is given of some department activities: digital equipment for measurement of fast transients, conductivity measurement and temperature control of liquids, and hybrid-computer calculations (PDP-8 and EAI-680). (DENM)

10635 (RISO–M–640) PLOTTINGPROGRAM. Soerensen, I. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 16p. Dep.

The program plots spectra from the TMC multichannel analyzers with six or ten digits/channel and from nuclear data multichannel analyzers with five or six digits/channel, in different scales. It is easy to include procedures for input of data tape from other analyzers. (auth)

10636 (SC-RR–67-2964) THE MEANING OF RECEIVER NOISE FIGURE IN THE PRESENCE OF A HOT PLASMA SHEATH. Chaffin, R. J. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. Contract AT(29-1)-789. 20p. Dep. CFSTI.

Two models are examined to determine the effects on receiver noise figure of hot plasma surrounding a reentering space vehicle. (auth)

10637 (UCID–15210) ELECTRICAL ENVIRONMENT OF INSTRUMENTATION DURING THE WISHBONE NUCLEAR EVENT. Vogtlin, George (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 10, 1965. Contract W-7405-eng-48. 8p. Dep. CFSTI.

An investigation to determine the electrical environment of instrumentation at the Mouse House located 750 feet west of ground zero on the Wishbone Event is reported. The primary purpose

of the instrumentation was to measure low level signals near ground zero. (W.H.K.)

10638 (Y-1599) IMPROVED APPARATUS FOR THE ELECTRODEPOSITION OF URANIUM FROM URINE. Brown, L. D.; McBryde, W. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 5, 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

An apparatus now in use that has improved the electrodeposition efficiency for recovering uranium from urine by 100 percent (from 40 to 80%) is described. The electroplating time has been reduced by 50 percent (from 60 to 30 minutes). Operation of the equipment is now fully automated following the addition of the urine solution to the electrodeposition cells and the application of power. (auth)

10639 A COMPACT 200-kV DC POWER SUPPLY. Szabo, Zoltan. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 367-72 (1967). (In Hungarian).

A 200-kV, 2-mA, insulating-core transformer, developed and built for a neutron generator, is described. The power supply is 650 mm in diameter, 850 mm high and weighs 330 kg. (auth)

10640 PLASMA LENSES. Musil, J.; Zacek, F. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 66-74(1968).

An analysis is presented of the possibilities of focusing the microwave energy by means of a magnetoactive plasma. The basic parameters of a plasma lens are calculated, and the way a magnetoactive plasma may be used in the making of lenses with a variable focal length is pointed out. (auth)

10641 STATISTICAL ANALYSIS OF MULTIFOLD COINCIDENCE CIRCUITS. Kalisz, Jozef (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 1067-76(1967).

The statistical model is formulated for mathematical treatment of the processes encountered in multifold coincidence circuits when the time spreads (whose distribution is assumed to be Gaussian) have to be taken into account. The general approach for evaluating the coincidence surface and the coincidence curve is given. Two methods are presented for determination of the coincidence-circuit statistical parameters (resolving time, jitter breadth, efficiency) on the basis of a single empirical coincidence curve and their features are discussed. The generalization of some earlier investigations in this field is also presented. (auth)

10642 TIME-DOMAIN METHOD FOR CALCULATING NOISE OF ACTIVE INTEGRATORS USED IN PULSE AMPLITUDE SPECTROMETRY. Deighton, M. O. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 58: 201-12(Jan. 1968).

A time-domain method of calculating noise in pulse-amplifying systems, such as those employed in nuclear pulse spectrometry, is presented. The method appears to be generally applicable to linear time-variable systems, where the pulse processing involves a mixture of analogue and digital techniques, as well as to more conventional arrangements, for example those employing single or multiple delay-line shaping, where it greatly simplifies the mathematics. Specific results given here refer to the active integrator system of Kandiah, of which two types have been analyzed; in one of these the CR coupling time constant is switched. The latter system, with suitable parameter values, yields a noise/signal ratio only 1.6% greater than the ideal cusp-response amplifier. Noise maps are included for a few cases of interest, since these permit graphical optimisation of system parameters for least resolving time. Consideration is also given to output signal dependence on detector collection time. Full details of the analysis will be published elsewhere. (auth)

10643 MULTISTAGE DELAY LINE MEMORY SYSTEMS AND THEIR APPLICATION TO MULTI-CHANNEL PULSE HEIGHT ANALYZER FEATURING SHORT DEAD TIME. Takaba, S. (Tokyo Univ.). Nucl. Instrum. Methods, 58: 223-8(Jan. 1968).

Memory systems which use two or three ultrasonic delay lines of the same bit rate to decrease the dead time of the Hutchinson-Scarrot type pulse height analyzer are described. Ingenious channel allocation in the long delay line for the main store enables the periodic transfer of the counts from the short delay line used as the temporary store, and this transfer technique can be extended to the system with three delay lines. The counting loss of each channel in these systems including the loss by overflow in the temporary store is calculated as a function of channel concentration factor (relative input counting rate to the channel), α_i. The system with two delay lines has a reduced dead time of about one tenth of that in the conventional system. The dead time is further reduced by a factor 2 in the system with three delay lines. The experimental model with two magnetostrictive delay lines proves the feasibility of the system. (auth)

10644 DESIGN OF THE CONSTANT FRACTION OF PULSE HEIGHT TRIGGER FOR OPTIMUM TIME RESOLUTION. Gedcke, D. A.; McDonald, W. J. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods, 58: 253-60(Jan. 1968).

The constant fraction of pulse height trigger has been shown previously to provide the optimum time resolution with a scintillator-photomultiplier system. The principle is discussed in detail in this paper and a circuit suitable for general use is presented. Over a 100 : 1 dynamic range the walk is within ±120 psec. The lower threshold is variable from 0.8 mA to 10 mA on the anode pulse height. A comparison is made with other commonly used timing methods. (auth)

10645 MEANS OF INCREASING THE EFFECTIVE STORAGE CAPACITY OF A MEMORY FOR PARTIALLY CORRELATED DATA. Waugh, J. B. S. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods, 58: 293-7(Jan. 1968).

A method of increasing the effective word size of a memory by the storage of differences of, rather than the spectra themselves, is described. Algorithms for storage and recovery using various differencing are given. An example showing a spectrum obtained using first differences is presented and various ramifications of the technique are discussed. (auth)

10646 INCREASING THE FLEXIBILITY OF A COMPUTER USED FOR SIMULTANEOUS DATA COLLECTION AND COMPUTATION. Hobbie, R. K.; Goodwin, R. W. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1265. Nucl. Instrum. Methods, 58: 342(Jan. 1968). (COO-1265-52).

The flexibility of a computer system is increased by allowing one to save loaded programs on the end of the library tape and restore them later to their original location. (auth)

10647 STATISTICS OF DIGITAL STABILIZERS. Ferguson, J. M. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 58: 318-24(Jan. 1968).

Many pulse-height analysis systems include devices which continually readjust the gain of the system on the basis of digital information recorded in the pulse-height analyzer. The gain of such a system fluctuates because of the counting statistics. This effect is studied as a function of the parameters of the stabilizing system, and in comparison with the ability of the system to compensate for electronic drift. (auth)

10648 A HIGH PRECISION "SIGNACON" MASS-METER. Lloyd, R. A.; Hodgson, A. E. M. (National Physical Lab., Teddington, Eng.). Nucl. Instrum. Methods, 58: 298-302(Jan. 1968).

A mass-meter system is described which displays the quantity H^2/V, which is proportional to the mass number of the isotope received at the collector of a separator. H is measured by a rotating coil, H^2 is obtained from a squarer, and the ratio H^2/V is formed in a digital voltmeter operating in the ratio mode. The parameters of the system are evaluated. It is shown that if the resolving power of the mass-meter is equal to that of the separator, the sensitivity of the mass-meter must be proportional to $1/M$. It is also shown that the system can be frequency-compensated. Mass-meters based on two different types of squarers are described. A mass-meter using a Signacon (a multi-junction thermal converter) has a resolving power of 8,000 at mass 800. (auth)

10649 SUPERCONDUCTING COILS FOR SPECIAL APPLICATIONS. Lucas, E. J.; Stekly, Z. J. J. (Avco Everett Research Lab., Everett, Mass.). pp 579-88 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Because of their tendency to lose their superconductivity during transient operations, very little consideration had been given to the use of superconducting coils in systems intended for field use. However, with the development of stabilized superconductors, interest has been aroused in the possibility of utilizing superconducting coils as components in systems to be used outside the laboratory. A general description of two superconducting coil programs which have come into being because of this interest is presented. The first of these programs is concerned with the problems associated with the use of superconducting coils as energy storage elements in pulsed systems. In this application the coil must be able to withstand charge rates of a few seconds duration and discharge rates of a few milliseconds duration without sustaining a superconducting-to-normal resistance transition. Two energy storage systems were built as part of this program. The coils used in each of these systems were wound with a stabilized superconductor composed of nine 0.0254 cm Nb–Zr wires, imbedded in a 0.102 cm × 1.27 cm copper substrate. The first

system made use of a single-layer solenoid having an overall length of 38 cm and a measured inductance of 8.35 mH. The second system made use of a 99-cm-long solenoid having an inductance of 1.92 mH. Both of these systems have been successfully operated at charge times of two and three seconds respectively, and discharge times of two milliseconds. The maximum energy content for a single output pulse from the first system was approximately 7,300 J at 1,350 A, and for the second approximately 60,000 J at 8,000 A. When operated at its design current of 10,000 A, this second system will deliver a 96,000-J output pulse. The second program has as its end objective the construction of a superconducting coil system capable of being used as part of an instrumentation package during the flight of an Apache rocket. The coil being used for this system is capable of supplying a central field of 30,000 G, uniform to within 1%, over an 8-cm axial length in a 7-cm bore, at an overall current density of 1.62×10^4 A/cm^2 in the coil windings. The overall length of the Dewar system is 30.5 cm and its outside diameter is 14.9 cm. The helium boil-off rate for the Dewar is approximately 0.2 liters per hour with the coil in place and operating in a persistent current mode. (auth) (UK)

10650 VERY HOMOGENEOUS MAGNETIC FIELDS WITH SUPERCONDUCTING COILS. Sauzade, M.; Taquin, J.; May, E.; Pontnau, J. (Faculte des Sciences, Orsay, France). pp 599-602 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Some high homogeneity coils have been built at Orsay for high resolution nuclear magnetic resonance and electronic resonance research, and many experiments have been made with them. Some specific characteristics of their use are described. (auth) (UK)

10651 ENHANCEMENT OF THE MAGNET FIELD IN SUPERCONDUCTING MAGNETS USING POLE-PIECE MADE OF RARE-EARTH METALS. Bonjour, P.; Septier, A. (Faculte des Sciences, Orsay, France). pp 611-16 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Some rare-earth metals (Gd, Tb, Dy, Ho, Er, Tm) become ferromagnetic at very low temperatures. For Gd, Er, Dy, and Ho the magnetization M_s is higher than for pure iron. Dy and Ho are particularly interesting, their respective M_s values being higher than those of the better cobalt steels. Another difference between Ho, Dy and iron (or steel) is due to the fact that saturation is only obtained in very high fields ($H \simeq 50$ to 80 kOe); their relative permeability $\mu_r = \mu/\mu_0$ is always greater than unity, and even in high fields, pole-pieces made of Ho or Dy may be used as flux concentrators. For Fe, Co-steel, and rare-earth metals, approximate values for Curie temperatures θ_c are tabulated, and the values of M_s (magnetization in an infinite applied magnetic field) can be obtained by extrapolation to the origin of the measured linear function $M = f(1/H)$. In the case of Dy a characteristic break-up in this line is always present around $H \simeq 12$ kOe; the slope of the function increases abruptly and, by extrapolation to zero of both parts of the curve, two values of M_s are obtained; both values are indicated in the table. Ho gives a regular variation of M_s versus H^{-1}, and therefore the unique value of M_s is given. These metals would appear to be very interesting with regard to superconducting coils, to obtain high fields in small volumes by flux concentration. This possibility was explored. (auth) (UK)

10652 SQUARE-LOOP FLUX STANDARD: A PRECISION PULSE GENERATOR. Macondray, F. W. (Univ. of California, Berkeley). pp 639-45 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

A square-loop flux standard (called SLUFUS) is a simple and reliable device for calibrating a search coil and integrator magnetic-field-measuring system. A reproducible $V \cdot dt$ pulse is generated by reversing the magnetization of a temperature-controlled, temperature-compensated, toroidal-core transformer. The core is a Ni–Fe alloy, with a square hysteresis loop. Output pulses in the range 0.01 to 1.0 volt-second (10^6 to 10^8 maxwell-turns) can be selected. Accuracies of 0.03% and better are achieved with relatively simple circuits. The following objects are discussed: typical uses; operation of the basic device; temperature compensation of the toroid; performance history; design example. (auth) (UK)

10653 THE RAPID MAPPER: A DATA-ACQUISITION SYSTEM FOR LARGE-SCALE MAGNETIC FIELD MEASUREMENTS. Macondray, F. W. (Univ. of California, Berkeley). pp 646-53 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Large-scale digital magnetic-field mapping is extensively used at the Lawrence Radiation Laboratory. An automated measuring system, called the Rapid Mapper, was built in 1962 and rebuilt in 1964. This machine is designed to perform a variety of automatic and semimanual dc measurements. In the automatic modes the machine positions a probe, sequences the measurements, and records the data for later computer analysis. The semimanual modes are used when computer analysis of manual data is desired. A third-generation Rapid Mapper is now in the planning stage and will be controlled by a small digital computer. It will contain all the abilities of the preceding machines, and in addition will be able to make digital pulsed-field measurement and also do error checking at the time of measurement. The use of a computer will greatly facilitate modification of test programs. One of the first projects for this machine will be model magnet studies for the 200-GeV accelerator. The paper discusses organization of the system, probe positioning, and flow diagrams of the control logic. (auth) (UK)

10654 THE USE OF A HIGH SPEED DATA ACQUISITION SYSTEM IN MEASURING LARGE VOLUME MAGNETS AT THE ZERO GRADIENT SYNCHROTRON. Berrill, E. C.; Odwazny, R. S. (Argonne National Lab., Ill.). pp 675-82 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The need for measuring time-variant magnetic fields in connection with the development program of the Zero Gradient Synchroton's (ZGS) guide field magnets led to the development of the system described, in January 1958. The early four-channel version was used to measure the effects of eddy currents in 1/4th scale and 1/7th scale models. During 1961 the present 15-channel size was developed, and used during the following year to measure all 128 magnet block assemblies of the eight octants comprising the ring magnet of the ZGS. With the advent of successful machine operation in 1963 it became necessary to produce accurate field maps of large spark and bubble chamber magnets. Measurement methods using a single search coil, moved from point to point for thousands of measurements, proved to be too time consuming and subject to human error. In order to increase the speed and accuracy of measuring these large volume magnets, many search coils were swept simultaneously through the magnets and their outputs were recorded using the High Speed Data Acquisition System. (auth) (UK)

10655 A HALL EFFECT MAGNETIC FIELD PROBE SYSTEM OF HIGH STABILITY. Reeve, P. A.; Swales, F. J.; Wroath, P. D. (Rutherford High Energy Lab., Chilton, Eng.). pp 693-98 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Precision measurements of the magnetic fields in the magnets used with the Rutherford Laboratory linac in the past were made with either a proton magnetometer or a calibrated servo-fluxmeter. The servo-fluxmeter has been used for field surveys in magnets with field gradients, and the proton magnetometer for the measurement of fields in homogeneous field bending magnets. Both of these systems require a degree of skill in their operation and do not give a direct indication; also the proton magnetometer cannot easily be used for precise measurements where large field gradients are encountered. Another difficulty with the proton magnetometer arises because of its poor signal to noise ratio, which is more or less inevitable with the large rf powers in use on the linac. In order to overcome these disadvantages consideration was given to either some modification of the proton magnetometer system, or to a complete change to a different type of magnetometer. The use of a Hall plate system was considered to have many advantages, one being that a direct reading system could be easily designed. The accuracy requirement for field measurement was specified as one part in 10^4, mainly because of nuclear physics requirements for the double focusing spectrometer. For this application the Hall Plate has a relatively large temperature coefficient (–0.04%/°C). The effect of temperature changes was reduced to a few parts in 10^6 by operating the Hall probe inside a change of state oven similar to that developed by the Marconi Company for crystal oscillators. (auth) (UK)

10656 SIMPLIFIED PROCEDURE FOR CLEANING ELECTRON-CAPTURE DETECTORS OF THE CONCENTRIC-TUBE

DESIGN. Starr, R. I.; Johnsen, R. E. (Colorado State Univ., Fort Collins). Analyst, 92: 657(Oct. 1967).

Although the electron-capture detector is sensitive for the detection of such compounds as the chlorinated insecticides, contamination of the detector, with a resulting loss in standing current, is an inherent problem. Some difficulty has been experienced in removing and replacing the foil without forming wrinkles or gaps between it and the tube wall. In this paper a simplified ultrasonic procedure is described for cleaning the detector foil, without removing it from the cell. (auth)

10657 ISOTOPE RATIO MEASUREMENT BY PEAK MATCHING. Dodson, M. H. (Univ. of Leeds, Eng.). J. Sci. Instrum., 44: 775-6(Sept. 1967).

A decade voltage divider was incorporated in the feedback circuit of a mass spectrometer amplifier. It provides a sensitive gain control which is linked with a peak selector switch; while switching between two peaks the voltage divider setting is adjusted until the peaks are matched on the chart recorder output. The ion beam ratio is given directly by the setting of the divider. The system provides a rapid method of estimating isotopic abundance ratios without chart measuring with a precision of up to 0.2%. Using an expanded-scale recording system it is possible to attain higher precision (better than 0.1%). For solid source work the method has the advantage over double collection methods of being free from errors due to variable transmission of ion beams. (auth)

10658 SELF-BALANCING CURRENT REGULATOR FOR MEASUREMENT OF CRITICAL CURRENTS OF SUPERCONDUCTORS. Bellau, R. V. (General Electric Co. Ltd., Wembley, Eng.). J. Sci. Instrum., 44: 793-4(Sept. 1967).

An electronic system is described which automatically adjusts the current through a superconductor to maintain a small prescribed p.d. across it. Owing to the employment of a galvanometer–amplifier in the initial stage of amplification, the unit has extremely high voltage sensitivity and low thermal drift and is virtually insensitive to mains pick-up. It can be used in conjunction with an XY recorder. (auth)

10659 INTRODUCTION TO THE PROBLEMS AND METHODS OF AUTORADIOGRAPHY. Schmidtborn, I. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 9: 508-12(1967). (In German).

Ionizing radiation blackens photographic emulsions. This effect is used in autoradiography to detect and determine the distribution of low-level activities in a sample. Knowledge of the various influences on the resolution and the density of an autoradiograph is a precondition for the choice of the proper film, the correct process of fabrication, and a suitable exposure time. Under certain conditions autoradiographs can even be evaluated quantitatively. The methods most commonly employed are outlined briefly. (auth)

10660 NEW MULTILOBE NETWORK FOR OBTAINING INSTANTANEOUS IMAGES OF THE SUN AT 169MHz. Daigne, Gerard; Oudet, Chantal; Vinokur, Marc (Observatoire de Meudon, France). Compt. Rend., Ser. A and B, 265: 949-52(Oct. 23, 1967). (In French).

Beginning with the old East-West lattice at Nancay, operating at 169 MHz, a new 31 lobe assembly was constructed with a separating capacity of 3'8 lobes placed equidistance at 2'. The installation makes it possible to obtain on film one-dimensional instantaneous images of the sun. (tr-auth)

10661 WIDE-RANGE 50-psec-RESOLUTION DIGITAL TIME SORTER. Cottini, C. (CNR, Bologna. Istituto di Elettronica, Bologna); De Lotto, I.; Dotti, D.; Gatti, E.; Vaghi, F. Energ. Nucl. (Milan), 14: 704-12(Dec. 1967).

The functional principles and the techniques employed in the development of an instrument fit to measure very short time intervals are described. The most important feature of the presented instrument is the high resolution performances (50 psec) obtained even for measured time intervals long with respect to the resolution (about 5 μsec). The instrument long-term stability is guaranteed by a quartz controlled oscillator. (auth)

10662 AN ELECTROSTATIC PROBE FOR IONOSPHERIC MEASUREMENTS OF DENSITY AND ELECTRON TEMPERATURE. PART I. PRINCIPLES OF FUNCTIONING AND LIMITS OF THE DEVICE. Bruscaglioni, P. (Univ., Florence). Alta Freq., 36: 538-45(June 1967). (In Italian).

In conjunction with the programs set up by the Italian Commission for Spatial Research, an electrostatic probe has been designed and constructed at the Microwave Center of CNR for measuring density and electron temperature in the ionosphere. The probe is designed to be carried in a Nike Apache rocket but with nonessential modifications may be placed in other vehicles. The principles and functioning of the probe are described and causes of error are examined. Among these are disturbances introduced by movement of the vehicle, and imperfect uniformity of the potential at the plane of the analyzer for electron temperature. Errors less than 10% are calculated to be made at altitudes between 100 and 170 km. (BBB)

10663 POWER SCAVENGING DE-Q'ING CIRCUIT FOR A LINE-TYPE PULSER. Smith, William I. (to United States Atomic Energy Commission). U. S. Patent 3,363,184. Jan. 9, 1968.

A de-Q'ing circuit that alters a resonant-charging circuit in a line-type pulser to a condition of nonresonance and scavenges the power remaining in the charging circuit at the end of a charging cycle is described. A rectified power supply is connected to the charging circuit which includes a charging choke. The choke is de-Q'ed and the power is scavenged by means of a special winding inductively coupled to the choke winding. The special winding is connected across an output filter capacitor of the power supply through a circuit which is rendered conductive at the end of each charging cycle. The power in the magnetic field of the choke at the end of the charging cycle is coupled to the special winding for transfer to the power supply filter capacitor. (AEC)

10664 FREQUENCY TUNING OF AN ENERGETIC ARC DISCHARGE BY VARYING THE DIAMETER OF THE CYLINDRICAL HOLLOW ARC. Flowers, John W.; Dunnill, W. A. (to United States Atomic Energy Commission). U. S. Patent 3,363,130. Jan. 9, 1968.

A method is described for adjusting the size of the reflector electrode in an arc discharge device, thus varying the size or diameter of the cylindrical arc discharge. The adjustment of the arc diameter provides a method for easily and accurately tuning the arc discharge such that it is possible to attain a dominant frequency equal to the ion cyclotron frequency of the gas used which provides for optimum operation of the arc discharge. (AEC)

10665 SURFACE CONTAMINATION SAMPLER. Royster, George W. Jr.; Fish, B. R. (to United States Atomic Energy Commission). U. S. Patent 3,362,141. Jan. 9, 1968.

A device is described which is capable of gathering samples of possibly contaminated dust-like particulate matter from work area surfaces. The device is a tubular open-ended housing with a plurality of inclined passageways circumferentially spaced outside the housing and communicating with the interior a removable filter disposed inside. The housing is placed against a surface to be sampled and compressed air is passed through the passageways to drive the particulate matter from the surface and into the filter where such matter is retained for subsequent examination. (AEC)

10666 LINEAR RESPONSIVE MOLTEN METAL LEVEL DETECTOR. Miller, William R.; Thacker, L. H. (to United States Atomic Energy Commission). U. S. Patent 3,366,873. Jan. 30, 1968.

A linear responsive molten metal level detector, in which the level is monitored external to a nonmagnetic containment vessel by three elongated, rectangular, stacked coils mounted on the vessel and having the axis oriented perpendicular to the direction of movement of the molten metal, is described. The difference in the voltages induced in the innermost and outermost coils by the suitably energized center coil, due to the relative proximity of the coils to the conducting molten metal, will provide a linear and accurate output signal indicative of the level of the molten metal within the vessel in a range determined by the length of the coils. (AEC)

10667 A MICROSCOPE COMBINED WITH A VACUUM DEVICE, SUCH AS A ROD DOSIMETER. (to Telefunken Patentverwertungsgesellschaft mbH). British Patent 1,097,259. Jan. 3, 1968. Priority date Feb. 18, 1965, Germany.

The design of a microscope built into a vacuum system for observing a reading scale inside the vacuum system is described. This apparatus is particularly concerned with a microscope combined with a radiation dosimeter. (W.H.K.)

10668 PRIMENENIE TUNNEL'NYKH DIODOV V PRIBORAKH YADERNOI FIZIKI. (Use of Tunnel Diodes in Nuclear Physics Instrumentation). Ivanov, A. A.; Kolpakov, I. F.; Timokhin, L. A. Moscow, Atomizdat, 1967. 212p.

Questions connected with the work characteristics of tunnel diodes, methods of calculation, and use of tunnel diodes in nuclear physics devices are examined. The systematics and analysis of data on the use of tunnel diodes in individual circuits of physics devices (generators, forming devices, discriminators, converters, logic circuits, and memory devices) were reported, based on published data. The circuits described have a concrete character

which can be of use during application of the data reported. (tr-auth)

10669 CALCULATION OF INTENSITY AND RESOLUTION FOR FIXED SCATTERING ANGLE AND FIXED WAVELENGTH DOUBLE AXIS POWDER CRYSTAL NEUTRON DIFFRACTOMETERS. Hamasaki, Seishi. Madison, Wis., Univ. of Wisconsin, 1967. 150p.

Thesis.

Expressions for the intensity and resolution of double-axis powder-crystal neutron diffractometers are obtained in this thesis. The formulae are obtained by combining the collimation factors of the neutron beam with the reflectivity, including spatial effects, of the neutron beam from the crystal. The formulae for a fixed scattering angle and a fixed wavelength diffractometer are compared, and the inverse relation of the two formulae with respect to the neutron paths in each diffractometer are obtained. The dependence of the diffraction intensity and resolution on the mosaic spread of the single crystal analyzer for a fixed scattering angle diffractometer is numerically investigated. The result shows that there is an optimum mosaic spread which gives the maximum intensity for a given diffraction peak. The dependence of the intensity and resolution on the horizontal angular divergences of the first and third collimator are also obtained numerically. The analysis indicates that a fixed scattering angle diffractometer, the diffraction intensity is much more sensitive to the horizontal angular divergence of the third collimator than to that of the first collimator contrary to the case in a fixed wavelength diffractometer. The numerical calculation of the diffraction intensity of a nickel powder crystal for the fixed wavelength diffractometer installed at the ISPRA-1 reactor is obtained and is compared with experimental data previously obtained. (Diss. Abstr.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 11018.

10670 (HMI-B-63) WIRKUNG VON REAKTOR-NEUTRONEN AUF DIE EIGENSCHAFTEN VON SILIZIUM-ZENER-DIODEN. (Effects of Reactor Neutrons on the Properties of Silicon Zener Diodes). Wagemann, H. G.; Zander, K. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Dec. 1967. 27p. (In German). Dep.

Current voltage characteristics of silicon Zener diodes belonging to the ZF family (INTERMETALL) (ZF 3,9; ZF 5,6; ZF 8,2) were measured for current injections of (10^{-7}–10^{-2})A and at different temperatures (+190°C, −79°C, 0°C, 30°C, 60°C, 90°C), before and after being irradiated successively within the neutron flux of a reactor (dose steps of fast neutrons: 10^{14} cm^{-2}, 3.10^{14} cm^{-2}, 10^{15} cm^{-2}, 3.10^{15} cm^{-2}, and 10^{16} cm^{-2}). (auth)

10671 COMPARISON OF THE NEUTRON RADIATION TOLERANCE OF BIPOLAR AND JUNCTION FIELD EFFECT TRANSISTORS. Buchanan, B.; Dolan, R.; Roosild, S. (Cambridge Research Labs., Bedford, Mass.). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2188-9(Dec. 1967).

The radiation tolerance is defined to be the integrated neutron flux required to reduce the transconductance or common emitter current gain by a tolerable reduction factor. Using this definition, simplified gain models, and empirical data, general expressions are derived and comparisons made which indicate that the junction field effect transistor is inherently more radiation tolerant than the bipolar. (auth)

10672 EQUIVALENT CIRCUITS ESTIMATE DAMAGE FROM NUCLEAR RADIATION. Finnell, Joseph T. Jr.; Bertetti, David D.; Karpowich, Fred W. (Avco Corp., Wilmington, Mass.). Electronics, 40: 73-82(Oct. 30, 1967).

The effects of neutron and γ radiation from nuclear explosions on various components of electronic circuits are reviewed, along with means of estimating such effects, particularly with equivalent circuits. Through formation of electronhole pairs, photoelectric effect, and Compton effect, γ-ray effects may generate photocurrents in semiconductors, change the conductivities of conductors and insulators, and create leakage paths in component packages. The absorption of large doses of γ energy by the materials can severely overheat the components. Neutrons more energetic than 1 MeV can cause crystal dislocations and other irrecoverable forms of damage. Production of numerous hole-electron pairs in and near carrier depletion regions makes a transistor or diode act as an additional power source in the circuit. Neutron damage in solid-state circuits usually results in a decrease in the forward current gain of transistors. Neutrons also may cause permanent degradation of cutoff-collector current, collector-to-emitter voltage, collector-saturation voltage, and the equivalent circuit base resistances. Gamma rays may cause essentially the same lattice-displacement effects as neutrons, but these are far less troublesome in semiconductor devices than the heat generated by γ irradiation. The mode and effect of damage in various circuit components are examined in detail. It is shown how, by use of device models, circuit designers can calculate the effects on components and then compute the over-all response of a circuit. (BBB)

10673 SIMULATED SPACE EFFECTS ON MICROELECTRONIC DEVICE MATERIALS. Lee, S.; Fewell, R. (Autonetics, Anaheim, Calif.). pp 149-57 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

The effects of simulated space effects viz., vacuum and radiation have been applied to microelectronic device materials. Experiments have been conducted on devices and materials used in computer multilayer board assemblies, integrated circuits, capacitors and connectors. In addition studies have been performed on bonding adhesives used in integrated circuits. Outgassing experiments have indicated that absorbed and occluded gases are the primary constituents evolved by microelectronic devices tested in the 10^{-6} Torr vacuum region. Molecular species having mass numbers higher than 44 were only observed in minute quantities. The magnitude of atmospheric constituent outgassing has shown that high speeds and reserve pumping capacities are essential to long term space vacuum simulation. Preconditioning of test specimens was required in order to achieve hard vacuum. Microelectronic circuit devices including those with intact hermetic casing and punctured were found to operate within tolerance up to 90 days. The in-vacuum operational tests of many different devices with a punctured or totally removed case was performed in order to ascertain the criticality of leakage in a long term space vacuum environment from microelectronic devices which are normally hermetically sealed. Adhesives used in bonding electronic materials were subjected to vacuum and radiation environments. Some loss in adhesive properties was observed with the group of adhesives tested in both vacuum and thermal vacuum. Gamma radiation had an effect on only the Eastman 910 adhesive. Wet tantalum electrolytic capacitors have shown material deficiencies under space vacuum environment. One-fourth of the samples presently under test have failed. Partial pressure analysis of the ambient has not shown any evidence of electrolyte leakage. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 10554, 10739, 10740, 10762, 10772, 10778, 10784, 10835, 10856, and 10895.

10674 (BNWL-480) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT, 1966 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME I. BIOLOGICAL SCIENCES. Thompson, R. C.; Swezea, Evelyn G. (eds.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 207p. Dep. CFSTI.

Separate abstracts were prepared for the eight major categories of the report. (E.R.B.)

For abstracts of individual sections see: 10675–10677, 10739, 10740, 10824, 10825, and 12158.

10675 (BNWL-480, pp 21-54) TOXICITY OF RADIOELEMENTS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Data are reported on ^{90}Sr toxicity in miniature swine, with emphasis on the neoplastic effects of chronic ingestion. Metabolism of ^{90}Sr in pygmygoats and phispholipid turnover in marrow and blood cells of ^{90}Sr-burdened rats are discussed. Progress is also reported on studies of deposition, retention, and biological effects of a variety of radioisotopes in rats in relation to age. (E.R.B.)

10676 (BNWL-480, pp 85-97) SPACE NUCLEAR SYSTEMS STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The biological problems connected with the use of reactors or radioisotope power sources in space are considered. Of primary concern, are the plutonium oxide microspheres to be used as power sources. Inhalability, deposition, and retention in the lungs and the effects of ingestion on the gastrointestinal tract are examined. Data are presented on: inhalation studies in dogs and miniature swine; gastrointestinal passage time in rats; and the effects of particle size density, and wind velocity on the environmental redistribution of these microspheres. (E.R.B.)

10677 (BNWL-480, pp 99-106) COMBATING DETRIMENTAL EFFECTS OF RADIATION. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Removal of internally deposited radioisotopes is discussed. Results of a study of the effects of chilling and tourniquet application on the sorption of plutonium nitrate implanted subcutaneously in the foreleg of swine are reported. An investigation of the rate of phagocytosis of $^{239}PuO_2$ particles from the peritoneal cavity of rats showed that the rate was affected by particle size and was inhibited by simultaneous administration of DTPA. Use of a uranium-DTPA complex as a contrast-medium in angiography incited cardiac arrest in swine. (E.R.B.)

10678 (JUL-492-ZO) LEBENDBEOBACHTUNGEN UND ELEKTRONENMIKROSKOPISCHE UNTERSUCHUNGEN DER NEUENTSTEHUNG VON MITOCHONDRIEN IN GEZUECHTETEN HUEHNERHERZZELLEN. (Live Observation and Electron Microscopic Investigation of the Origin of Mitochondria in Growing Corn Kernel Cells). Wendt, Ernst; Schaefer, Dieter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Zoologie). June 1967. 20p. (In German). Dep.

In irradiated and unirradiated chicken heart myoblasts cultivated in vitro, the formation of mitochondria was studied by means of phase contrast and electron microscopy. By phase contrast observations of the living object it was found, that six to seven hours after irradiation with 2400 R, the number of functionally active mitochondria decreased: subsequently there appeared in the cytoplasm numerous small spherical pre-mitochondria that soon increased in number and developed into mitochondria of normal size and structure. The endoplasmic reticulum produces buds that must be considered as young pre-mitochondria. While they are still attached to the reticular system or after detaching from the endoplasmic reticulum they begin to establish an interior membrane. Later on, in limited areas, the spherical pre-mitochondria show the typical arrangement of cristae mitochondriales and simultaneously they increase in length. Therewith the pre-mitochondria assume a club-shaped form the spherical portion of which is filled with a dense ground-substance. This ground-substance obviously produces the material for the further formation of cristae mitochondriales that accompanies the outgrowth of the mitochondrial tube. Thus the pre-mitochondria transform into the definitive mitochondria. (auth)

10679 IONIZING RADIATION EFFECTS ON THE CONTENT OF CHLOROPHYLL, ASCORBIC ACID, AND DRY STUBTANCE IN COTTON LEAVES. Guseinov, S. G. (Azerbaidzhan State Univ., USSR). Dokl. Akad. Nauk Azerb. SSR, 23: No. 6, 45-8 (1967). (In Russian).

Leaves of Gossypium herbaceum were irradiated with ^{137}Cs using doses of 500, 1000, 2000, 5000 and 10,000 R. Doses up to 2,000 R increased the content and stability of the chlorophyll, ascorbic acid, and dry residue in various phases of cotton development. Doses of 5000 and 10,000 R inhibited the development and reduced the content of chlorophyll, ascorbic acid, and dry residue in the leaves. (R.V.J.)

10680 CHANGES OF SOME BIOPHYSICAL PARAMETERS OF THE BLOOD SERUM AFTER WHOLE-BODY X IRRADIATION. Hlavaty, Vlastislav; Zak, Miroslav; Jirounek, Petr; Bendova, Libuse (Charles Univ., Prague). Acta Univ. Carolinae Med., 12: 229-51(1966).

In attempts to develop a diagnostic method to detect the severity of accidental radiation exposure as soon as possible, changes of some biophysical parameters of serum were followed, particularly specific electric conductivity, surface tension, and viscosity, in the early stages of the postirradiation syndrome. Rabbits (Viennese white variety) were whole-body irradiated at doses of 250, 500, 1000, and 1500 R. The biophysical parameters were followed at time intervals from 15-min up to 48-hr postirradiation. An increase was noted in specific conductivity of the serum in relation to the time interval after irradiation and to the intensity of the absorbed dose of radiation. Parallel measurements of the concentration of some serum electrolytes (K, Na, and Cl) showed that the increase of the specific conductivity of the serum was mostly due to a decrease in Na and increase in Cl concentration. These changes were evidently not caused by alteration of protein structure or by changes of their concentration in the serum, as shown by an investigation of the changes of the specific conductivity in vitro and the absolute viscosity of the serum that did not appreciably change. A decrease, statistically nonsignificant, of the surface tension with increasing radiation dose was found. A mathematical expression was derived for the relation between the absorbed dose and the changes of the specific conductivity of the serum. With this equation, the changes of the specific conductivity could be used to estimate the absorbed dose. The changes in conductivity that were observed occurred immediately after exposure. (BBB)

10681 DETERMINATION OF RELATIVE PORE SIZE IN LIVING MEMBRANES OF NITELLA BY THE TECHNIQUES OF ELECTROOSMOSIS AND RADIOACTIVE TRACERS. Fensom, D. S. (Mt. Allison Univ., Sackville, Can.); Ursino, D. J.; Nelson, C. D. Can. J. Bot., 45: 1267-75 (Aug. 1967).

Methods employing radioisotopes were developed for measuring pore sizes of cell membranes. Carbon-14-labeled glucose and sucrose, of high specific activity were biosynthetically prepared using leaves of Canna indica. Electroosmotic efficiencies in Nitella flexilis were determined for a series of cations of different sizes and for K^+ ions in the absence and presence of chloroform, carbon tetrachloride, and indoleacetic acid (IAA). The results were compared with the permeation of the labeled glucose and sucrose in the presence and absence of electroosmosis, and in the presence of electroosmosis in cells treated with IAA. Both the plasmalemma and tonoplast were freely permeable to glucose but not to sucrose. However, in the presence of electroosmotic transport, sucrose did permeate the cell membrane and the permeation was enhanced by IAA. (BBB)

10682 REGENERATIVE POTENTIAL OF IMMUNOCOMPETENT CELLS. I. LACK OF RECOVERY OF SECONDARY ANTIBODY-FORMING POTENTIAL AFTER X IRRADIATION. Nettesheim, P.; Makinodan, T.; Williams, M. L. (Oak Ridge National Lab., Tenn.). J. Immunol., 99: 150-9(July 1967).

The radiobiologic studies reported are based on a model of cytodifferentiation of antibody-forming cells that postulates the existence of a cell compartment composed of pluripotential, immunologically uncommitted progenitor cells (progenitor cell compartment PC_1). When stimulated by antigen, cells of this compartment are believed to give rise to functional antibody-producing cells (primary response) and immunologically committed progenitor cells (progenitor cell compartment PC_2). On further antigenic stimulation, cells of PC_2 give rise to functional antibody-producing cells (secondary response). Factors that govern the pool size of the progenitor cell compartment PC_2 were examined, including the influx of cells from adjacent cell compartments, efflux of cells, and/or self-generation of cells within the compart-

ment. The recovery potential of the PC_3 cells compartment after x-ray exposures of varying magnitude was studied using an in vivo culture system of lymphoid cells. Spleen cell donor mice were immunized with rat red cells and four weeks later were irradiated at various x-ray doses (0, 200, 400, 600 or 700 R). At different times after irradiation, the spleens were used to prepare cell suspensions for assessing relative pool sizes of progenitor cells. The results showed that the minimum antigen dose necessary to initiate a near maximum antibody response was about 10^5 times greater for irradiated than for nonirradiated spleen cells. The compartment of immunologically committed progenitor cells (PC_3) lacked the potential to recover from an x-ray insult and appeared not to have significant self-generating potential. (BBB)

10683 IRRADIATED HAMSTER TEST FOR HISTOCOMPATIBILITY. Streilein, J. W. (Univ. of Pennsylvania, Philadelphia). Ser. Haematol., 11: 241-4(1965).

Lethally irradiated hamsters were used as an immunologically indifferent host for the cutaneous expression of homograft sensitivity developed by the inoculation of lymphoid cells from pairs of human volunteers. In a study of homograft sensitivity as mediated by normal and sensitized lymphocytes in hamsters, it was found that lethal irradiation of these animals rendered them immunologically nonreactive, but still capable of displaying delayed cutaneous sensitivity if induced by the intracutaneous inoculation mixtures of antigen and competent lymphoid cells. Albino animals of the isogenic MHA strain, weighing about 100 g, were subjected to 1500-R whole-body irradiation, and inoculations were made 28 to 30 hr postirradiation. Lymphocyte suspensions were prepared from peripheral blood. Skin lesions were read at 24-hr intervals. Comparison of the intensity of the skin reactivity induced by the inoculation of cells from a given pair of individuals with the least long-lived survival time of mutually exchanged skin homografts revealed that a positive correlation existed. The irradiated hamster test seemed capable of predicting gross histocompatibility as measured by skin homograft survival time. (BBB)

10684 SUBCUTANEOUS GROWTH OF EHRLICH'S ASCITES CARCINOMA AFTER SUBLETHAL WHOLE-BODY IRRADIATION. Thunold, Svein (Univ. of Bergen). Acta Pathol. Microbiol. Scand., 70: 259-66(1967).

The early intraperitoneal growth of the Ehrlich ascites carcinoma (EAC) was not changed after prior treatment of the host with whole-body irradiation in sublethal doses. Whether whole-body 300-R irradiation of the host 24 hr before transplantation might have any effect of the subcutaneous growth of EAC was studied, as well as changes in spleen weight and histology 24 hr after irradiation in nontumor-bearing mice and 8 days after irradiation in tumor-bearing mice. In nonirradiated mice, tumor growth was greater in the males than in the females. The female mice showed a greater increase in spleen weight than the males, and the spleens of both sexes showed histological evidence of immune response which suggested that tumor growth in the female was inhibited by their greater immune response to the EAC. This was further supported by the finding that when the immunological defense mechanism of the mice was depressed by whole-body irradiation and measured by histological criteria, no sex difference was apparent in either tumor size or host reactions. Also, tumor growth in irradiated females was significantly greater than in nonirradiated females. (BBB)

10685 STRUCTURAL CHARACTERISTICS OF HEMOLYTIC ANTIBODIES AS DETERMINED BY THE EFFECTS OF IONIZING RADIATION. Rosse, Wendell F. (Duke Univ., Durham, N. C.); Rapp, Herbert J.; Borsos, Tibor. J. Immunol., 98: 1190-5 (June 1967).

Information about the structure of macromolecules was obtained from studies on the effect of ionizing radiation on their biochemical activity. The effect of ionizing radiation on the hemolytic activity of rabbit IgG and IgM hemolytic antibodies was studied. Protein fractions of rabbit serum were irradiated in a beam of 2-MeV electrons generated in a Van de Graaff electrostatic accelerator or by a beam of 5-MeV protons generated in a linear accelerator. Antigen-binding capacity of hemolysin, unirradiated and irradiated, was measured by determining the number of sheep erythrocytes required to neutralize (absorb) hemolytic activity. Some structural characteristics of IgG and IgM hemolytic antibodies were then deduced by target theory analysis of the relation between the dose of radiation and inactivation of the molecule. Destruction of a single target with a molecular weight of 52,000 in the IgG molecule was sufficient to destroy hemolytic activity. These data are consistent with a model of the IgM molecule containing more than three subunits, each of molecular weight 1.6 to 1.8×10^5. In this model, each subunit was capable of combining with antigen and two adjacent subunits were required for the fixation of complement (C') and for hemolytic activity. (BBB)

10686 MATERNAL-FETAL IODINE METABOLISM IN THE RABBIT. III. ^{131}I STORAGE BY FETAL ORGANS. Lampe, L.; Kertesz, L.; Dzvonyar, J. (Univ. Medical School, Debrecen, Hungary). Acta Physiol. Acad. Sci. Hung., 31: 309-19(1967).

Deposition of radioiodine in fetal thyroid, gastric wall, gastric contents, skin, liver, and intestine of rabbits was studied 1, 2, and 24 hr after the injection of ^{131}I into the maternal animal. The fetal thyroid began to store ^{131}I on the 19th day, then it increased to peak values on the 30th day of intrauterine life. After 23 days the ^{131}I storage curve was similar in shape to that of the adult. The protein-bound iodide level was 0.8 to 2.4 μg/100 ml between 19 and 22 days of intrauterine life and rose to 5.5 to 5.8 μg/100 ml by the end of pregnancy. Before the onset of thyroid function, half of the total fetal ^{131}I content was found in the stomach, first in the gastric wall, then in the gastric contents. (BBB)

10687 MATERNAL-FETAL IODINE METABOLISM IN THE RABBIT. I. INTRAUTERINE GROWTH AND ^{131}I UPTAKE OF RABBIT FETUSES. Lampe, L.; Kertesz, L.; Dzvonyar, J. (Univ. Medical School, Debrecen, Hungary). Acta Physiol. Acad. Sci. Hung., 31: 289-301(1967).

To investigate radioiodine distribution during gestation, pregnant rabbits were given ^{131}I intravenously, and the content of ^{131}I was studied in maternal and fetal blood, thyroid, fetal organs, and in the placenta and amniotic fluid. In this way maternal-fetal iodine exchange and thyroid function were followed between the 12th and 30th days of gestation. Tests were carried out 1 hr after ^{131}I administration in 25 rabbits, at 2 hr in 13, and at 24 hr in 54 animals. In the fetuses ^{131}I activity was markedly high and decreased in proportion to the duration of pregnancy. Near the end of gestation, subcutaneously injected ^{131}I was absorbed rapidly and the serum level decreased faster than in nonpregnant animals. This was because the fetuses incorporated considerable quantities of ^{131}I. (BBB)

10688 EXPERIMENTAL STUDY OF THE INTRAVENTRICULAR INSTILLATION OF RADIOACTIVE GOLD. Rish, B. L.; Meacham, William F. (Vanderbilt Univ., Nashville). J. Neurosurg., 27: 15-20(July 1967).

Colloidal radiogold solution instilled intraventricularly in the hydrocephalic dog was selectively concentrated in and around the choroid plexuses. Histopathologic changes as a result of treatment with 10 to 20 μCi of ^{198}Au are described. Hydrocephalus was first produced by the injection of aluminum silicate (Kaolin) suspension into the cisterna magna, that provided a dilated ventricular system for accurate cannulation. Radioactivity indexes demonstrated that the isotope was selectively attracted to the plexus in concentrations as much as five times that in the ependyma with choroid plexus contact, 30 times that in ependyma without choroid plexus contact, and over 50 times cortical levels. The radioactivity appeared evenly distributed to the different plexuses regardless of their relation to the injection site. No foci of particulate ^{198}Au were found in the subarachnoid space overlying the cortex of the treated animals. No degenerative changes were noted in the surrounding glia or nearby neurons that could be attributed to ^{198}Au. At two and three months the gross and histological changes were the same as those seen earlier except that the plexuses showed more chronic fibrotic necrosis than acute hemorrhagic reaction. Normal nonhydrocephalic dogs that had received ^{198}Au intraventricularly showed no gross or histological effects; in fact, the isotope could not be located in the plexuses or ventricles. (BBB) (TSS)

10689 CONCENTRATION OF ^{82}Br IN THE THYROID GLAND OF RATS. Papadopoulos, S.; MacFarlen, S.; Harden, R. McG. (Western Infirmary, Glasgow). J. Endocrinol., 38: 375-80 (Aug. 1967).

The uptake of ^{82}Br by the thyroid gland in the rat after administration of ^{82}Br as ammonium bromide was investigated, and the concentration of ^{82}Br in muscle and blood was also determined. In untreated animals the radioactivity per unit weight of thyroid was greater than that of muscle but less than that of blood. This ^{82}Br level in the thyroid remained constant with time and was unaffected by perchlorate. After stimulation by endogenous thyroid-stimulating hormone (TSH) the thyroidal ^{82}Br concentration increased to a level slightly greater than that in blood. This effect was inhibited by perchlorate. It is concluded that, while under normal conditions ^{82}Br is not concentrated by the thyroid, after stimulation by TSH there is an increased uptake of ^{82}Br by the gland. There is no evidence that ^{82}Br is metabolized further in the thyroid gland. (BBB)

10690 MEASUREMENT OF BLOOD LOSS BY MEANS OF A WHOLE-BODY COUNTER. Holt, J. M.; Mayet, F. G. H.; Warner, G. T.; Callender, S. T. (Radcliffe Infirmary, Oxford). Brit. Med. J., 2: 86-8(Oct. 14, 1967).

A method is described for the measurement of blood loss over

periods of up to three months by means of ^{59}Fe and a simple whole-body counter. The principles involved are that seven to 10 days after the administration of ^{59}Fe all or most of the dose will be incorporated into circulating red cells. In normal males and postmenopausal females the whole-body radioactivity will remain stable and any loss in total-body radioactivity must represent loss of blood. The technique was evaluated in patients with polycythemia from whom blood was removed by venesection. Subjects were given an intravenous dose of ^{59}Fe-ferric citrate with 1.5 to 1.0 μCi activity. Others were given an oral dose of 5 mg of ferrous iron labeled with 5 μCi ^{59}Fe. In control subjects the whole-body counts expressed as a percentage of the count on day zero were plotted against time in days. The mean loss of ^{59}Fe per day was 0.031% ± 0.039%. The calculated blood loss per 100 days was 152 to 182 ml, and after correction for sampling losses were 90 to 142 ml (mean 117). In 12 patients with polycythemia the calculated volume of blood lost on each sampling was compared with the known volume of blood removed by venesection. The mean error was −0.2%, the range −22% to 23%, and the standard deviation of the error ±14%. It was concluded that the method is sensitive and accurate enough for clinical purposes, and blood loss of more than 700 ml can be measured with reproducibility of ±14%. To illustrate its application to clinical problems, studies of five cases of hypochromic anemia are described. (BBB)

10691 THE EFFECT OF Q-SWITCHED RUBY LASER RADIATION ON DERMAL TATTOO PIGMENT IN MAN. Yules, Richard B.; Laub, Donald R.; Honey, Richard; Vassiliadis, Arthur; Crowley, Lawrence (Stanford Univ., Palo Alto, Calif.). Arch. Surg., 95: 179-80(Aug. 1967).

Effects of ruby laser (6943 Å) radiation on skin and carbon pigment deposits in the dermis were studied. Irradiation was given in continuous bursts, or the laser was Q-switched with a solution of vanadium phthalocyanine in benzene such that the transmission was ~50%. At this concentration an output pulse of 10 nsec was obtained with an energy of 0.8 to 1 J corresponding to peak powers of 80 to 100 MW. It was found that long-pulse irradiation (1.8 msec duration) produced skin damage and eventual slough when applied in areas 2 to 3 mm in dia. Energy density was up to 73 J/cm^2. No discernible change was noted in the pigmentation. In contrast, the Q-switched irradiation caused complete blanching of the skin pigment and tattoo pigment at energy levels of 2 to 4 J/cm^2. Three-month follow-up showed apparent successful removal of 40 small areas of tattoo in a total of four subjects. (BBB)

10692 DETAILS ON THE POSSIBILITY OF DESTROYING THE GERMINAL PLASMA OF THE EGG OF RANA ESCULENTA WITH ULTRAVIOLET RAYS. Padoa, E. (Univ., Florence). Boll. Soc. Ital. Biol. Sper., 40: 272-5(Apr. 15, 1964). (In Italian).

Frog eggs were uv irradiated for 15 min at 45 to 360 min after artificial fertilization; this corresponded to irradiation of the different stages that occur during oogenesis. Gonads of the developing specimens were examined histologically for the presence of premordial germinal follicles. Compared with 100% normal gonads in the nonirradiated controls, those irradiated at 45 min showed only 18% normal gonads; primordial follicles were few in number or absent. After irradiation at 100 min after fertilization the percentage of normal gonads was 14%; 160 min, 10%; 170 min, 22%; 195 min, 100%, 220 min, 100%; 250 min, 100%; 250 min, 100%; 280 min, 80%; and 360 min, 75%. The maximal destruction of germinal elements by uv radiation occurred when irradiation took place at 160 min postfertilization, i.e. before the 2-blastomere stage. Irradiation during the 4- to 8-blastomere stages was ineffective and partially effective in the 16- to 32-blastomere stages. Possible mechanisms of this effect, involving the action of uv on RNA, are discussed. (BBB)

10693 PROPERTIES OF THE OPSONIC SYSTEM REGULATING IN VITRO HEPATIC PHAGOCYTOSIS. Saba, Thomas M.; Filkins, James P.; Di Luzio, N. R. (Univ. of Tennessee, Memphis). Res. J. Reticuloendothel. Soc., 3: 398-414(1966).

The influence of temperature, pH, oxygen, and heparin on hepatic phagocytosis of colloidal ^{198}Au and ^{131}I-labeled serum albumin and triolein was studied using an in vitro rat liver slice technique. Colloidal ^{198}Au with an average particle dia of 15 mμ was used. Heat-denatured radioiodinated human serum albumin aggregates were prepared, and the radioiodinated triolein emulsion consisted of glycerol, ^{131}I-triolein-labeled peanut oil, and alcohol-soluble soy bean lecithin in a ratio of 10 : 10 : 1 by weight, respectively. Phagocytosis of colloidal ^{198}Au and heat-denatured albumin by rat liver slices was minimal in Krebs−Ringer phosphate medium. In contrast, heparinized plasma markedly augmented the hepatic uptake of both colloids; a 17-fold increase in phagocytic uptake was observed over that which occurred in Krebs−Ringer phosphate. Although these two colloids are markedly different in size, the abs amount (μg) of colloid phagocytized by the liver slices in either medium was comparable with both particulate preparations. Hepatic uptake of the liquid emulsion was slight in either Krebs−Ringer phosphate or serum, and heparin addition markedly increased. Evidently the presence of heparin was essential for the expression of opsonin activity. Heating of serum to 60°C destroyed opsonic capacity for ^{198}Au. Phagocytic uptake of heat-denatured albumin was optimal over a temperature plateau of 27° to 37°C, but slight at 4°C. Colloidal ^{198}Au phagocytosis was optimal over a pH range of 7.2 to 8.5. In contrast, the phagocytosis of heat-denatured ^{131}I-albumin aggregates was maximal between a pH of 6.25 to 7.00. Anaerobic incubation slightly impaired colloidal ^{198}Au phagocytosis as compared to aerobic incubation. Barium sulfate adsorption markedly depleted serum opsonic capacity, and cellulose acetate electrophoresis demonstrated a selective depletion of the α_2-globulin fraction in treated serum. (BBB)

10694 METHOD FOR MEASURING PROSTATIC BLOOD FLOW WITH ^{133}Xe IN THE DOG. Anderson, Lennart; Dahn, Inge; Nelson, Curt-Eric; Norgren, Allan (Univ. of Lund, Sweden). Invest. Urol., 5: 140-8(Sept. 1967).

A new radioisotope method for measuring prostatic circulation was developed. For assessment of the tissue : blood partition coefficient of ^{133}Xe a dog was placed in a closed respiratory system of 6 l capacity, to which had been added 100 μCi of ^{133}Xe. After the dog had been in this system for 2 hr the prostate was surgically exposed, frozen, and rapidly removed. Determinations were made of the radioactivity per g of prostatic tissue and mm of blood in a well type scintillation detector. The quotient between the activity in prostatic tissue and blood was 0.6. After local infiltration into the prostate of ^{133}Xe, reproducible clearance curves were obtained. They were exponential even when the radioactivity was recorded logarithmically. Experiments with compression of the aorta and injection of the isotope into a dead dog showed that the isotope is not eliminated in the absence of circulation, i.e., the clearance is dependent entirely on the blood flow. Experiments with variation of the blood pressure and with local vasodilation and vasoconstriction showed that the rate of elimination of the isotope varied with the amount of blood flowing through the organ. Measurement of local blood flow by ^{133}Xe clearance offers several advantages over other methods. It is fairly simple and since the amount of isotope infected does not influence the elimination rate, a fixed dose is not necessary. Since ^{133}Xe is eliminated via the lungs, the recirculating isotope does not interfere with measurements. In addition, the rapid elimination of the isotope from the individual makes this method practically risk free. (BBB)

10695 COMPARISON BETWEEN THREE RADIOISOTOPE METHODS FOR MEASURING IRON ABSORPTION. Lunn, J. A. (Bahamas Government Medical Officer, British West Indies); Richmond, John; Simpson, J. D.; Leask, Joan D.; Tothill, Peter. Brit. Med. J., 2: 331-3(Aug. 5, 1967).

A simple, inexpensive whole-body counting technique was developed for measuring Fe absorption after an evaluation of three commonly used radioisotope techniques. These included: determination of retention of radioiron, after oral administration, by fecal recovery; the double isotope (^{55}Fe and ^{59}Fe) method; and whole-body counting with ^{59}Fe. It was shown that the whole-body counter used with couch geometry gave results in good agreement with those from the double isotope technique. A sitting position led to poorer agreement, presumably owing to redistribution effects. There was considerable discrepancy between the fecal recovery method and the other two methods, especially at the lower levels of Fe absorption. This difference was believed to be caused by incomplete fecal collections. In the simplified whole-body counting technique described, radioactivity was measured in three positions with the patient prone and supine. Only two measurements on the patient were required, each taking about 15 min. The apparatus cost ~£750, excluding the scaler. (BBB)

10696 STUDIES OF THE KINETICS OF THE ^{45}Ca EFFLUX OF GUINEA PIG AURICLES. Reuter, H.; Seitz, N. (Univ., Mainz). Arch. Pharmakol. Exp. Pathol., 257: 324-5(1967). (In German).

Characteristics of ^{45}Ca clearance in guinea pig auricles were measured at rest, during stimulation, with temperature changes, and at various extracellular Ca concentrations. The clearance velocity coefficient was 10 to 20% greater during contraction than at rest. Compared to the clearance at 35°C, the clearance at 25°C was ~0.62, and at 3°C it was ~0.29. The temperature coefficient was between 1.5 and 1.6. This value did not indicate any metabolically related transport mechanisms. Reduction of the Ca concentration from 1.8 to 0 m$\underline{M}$ reduced the clearance to ~60% of its value. It was concluded that a 1 : 1 exchange-diffusion indicated a mechanism independent of metabolism that was responsible for regulation of the intracellular Ca concentration. Exchange

of extracellular Na with intracellular Ca may also be an additional passive transport mechanism for Ca in the auricles. (BBB)

10697 ^{47}Ca ABSORPTION IN RATS WITH INDUCED HYPERTHYROIDISM. Williams, Gerald A.; Bowser, E. Nelson; Henderson, Walter J. (Univ. of Illinois, Chicago). Israel J. Med. Sci., 3: 639-42(Sept.-Oct. 1967).

Intestinal absorption of ^{47}Ca was altered in rats with induced hyperthyroidism. Young rats were rendered hyperthyroid with L-triiodothyronine (T3), and $^{47}CaCl_2$ was administered to T3-treated and control rats via intragastric tube (and intraperitoneally five days later). Serial plasma, stool, and urine specimens were analyzed for ^{47}Ca activity. Both the net absorption and true absorption of ^{47}Ca were significantly less in the T3-treated animals. In both groups the urinary ^{47}Ca was below 2% and the plasma Ca and P were normal, with no group differences. The plasma ^{47}Ca activity was significantly less in the T3-treated rats than in the control rats at all times evaluated from $\frac{1}{4}$ to 24 hr. The ^{47}Ca of femora excised 2 hr after intragastric ^{47}Ca administration was significantly lower in the T3-treated animals. These observations indicate decreased intestinal absorption of ^{47}Ca in rats with induced hyperthyroidism, and suggest that decreased Ca absorption may be a significant factor in the negative Ca balance found in hyperthyroid patients. (BBB)

10698 EFFECTS OF DIETARY EDTA AND CADMIUM ON ABSORPTION, EXCRETION, AND RETENTION OF ORALLY ADMINISTERED ^{65}Zn IN VARIOUS TISSUES OF ZINC-DEFICIENT AND NORMAL GOATS AND CALVES. Powell, G. W.; Miller, W. J.; Blackmon, D. M. (Univ. of Georgia, Athens). J. Nutr., 93: 203-12(Oct. 1967).

The effects of dietary ethylenediaminetetraacetate (EDTA) (300 ppM) and Cd (350 ppM) on metabolism and tissue distribution of ^{65}Zn were determined following a single oral dose in Zn-deficient and normal animals. The feeding of EDTA had no significant effect upon fecal excretion or tissue distribution of ^{65}Zn. However, there was a marked increase in urinary ^{65}Zn excretion among the EDTA-fed animals that persisted throughout the experimental period. Dietary Cd decreased absorption and tissue concentration of ^{65}Zn. When ^{65}Zn was calculated as percentage of absorbed dose, most tissues of Cd-fed animals contained amounts comparable to those of other animals. However, livers of Cd-fed calves, but not goats, had more ^{65}Zn as a percentage of absorbed dose than livers of other animals. Cadmium had little effect on urinary excretion of ^{65}Zn. In general, the effects of dietary EDTA and of Cd in Zn-deficient animals were comparable to those in normal animals. (BBB)

10699 LIPID CHANGES IN THE LIVER CELL FRACTIONS OF RATS AT DIFFERENT DEVELOPMENTAL STAGES AND OF X-IRRADIATED NEWBORN RATS. Haude, W.; Goetze, E. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 19: 1-8(1967). (In German).

Along with ultrastructural studies on rat liver cells at different stages of development and pregnancy, phosphatides were determined in the liver cell fractions of the fetus on the last days of pregnancy, of newborn, and female pregnant and nonpregnant rats. Consistent with the observed expansion of the endoplasmic reticulum the total phosphatides in the liver of 28-hr-old animals increased compared with that in the fetus, and were still higher in the maternal liver. They were almost equally distributed in the cell fraction (mitochondria about 50%, microsomes about 25%). The relatively high phosphatide content of the nuclear fraction of fetuses and newborn rats seemed to be related to their content of erythroblast nuclei. Expansion of the endoplasmic reticulum in pregnant rats compared with nonpregnant ones corresponded to an increase in phosphatide content in the microsome fraction by 50%. Thin-layer chromatographic examinations of the phosphatide fraction revealed an increase in the lecithin component. A single whole-body x irradiation with 400 R of newborn and 1-day-old rats did not produce, within 4 hr, any changes in the content of phosphatides and total fatty acids of the liver cell fractions. (BBB)

10700 MATERNAL-FETAL IODINE METABOLISM IN THE RABBIT. II. DISTRIBUTION OF ^{131}I ADMINISTERED TO THE MOTHER IN PLACENTA, AND MATERNAL AND FETAL BLOOD. Lampe, L.; Kertesz, L.; Vachter, J.; Dzvonyar, J. (Univ. Medical School, Debrecen, Hungary). Acta Physiol. Acad. Sci. Hung., 31: 303-8(1967).

At 1, 2, and 24 hr following the intravenous injection of 50 μCi of ^{131}I in the form of KI into the maternal animal the activity in the maternal and fetal parts of the placenta was determined. Activity in maternal and fetal blood at 1 hr was practically identical, at 2 hr fetal blood activity was ~ twice, and at 24 hr, three times higher than maternal blood activity. In the maternal side of the placenta activity was the same as in maternal blood whereas in the fetal side of the placenta the activity was always higher than in maternal or fetal blood. Activity in amniotic fluid was comparable to that in fetal blood. The fetal part of the placenta was found to play an active role in iodine metabolism. (BBB)

10701 ^{131}I IN THYROID AND BLOOD AND ITS ELIMINATION IN THE MILK OF SHEEP. Manunta, Giovanni; Marongiu, Antonio; Nuvole, Paolo (Univ., Sassari, Italy). Arch. Vet. Ital., 18: 79-92(Apr. 30, 1967). (In Italian).

Radioiodine metabolism was studied in 15 sheep of the Sardinian breed (5 rams and 10 lactating ewes) following oral administration of 104 μCi ^{131}I. The ewes were in the 26th week of lactation and were milked once a day. The ^{131}I content of blood, thyroid gland, and milk was determined. Milk with the maximum level of ^{131}I was obtained in the first milking after ^{131}I treatment. During the first four day period the mean elimination of the administered dose was of 20%. Successively the ^{131}I level in the milk was lower and the total amount recovered during the 47 day period was the 22.3% ± 8.89% of the administered dose. The amount of ^{131}I recovered in the first milking was correlated with the amount of milk produced ($R = 0.64$), significant at the $P < 0.05$ level. The thyroid gland of males took up more iodine than that of lactating females: the difference between the means was significant at the $P < 0.1$ level. A negative correlation was found between the maximal thyroid radioactivity of the sheep and the total amount of milk secreted during the first week ($R = -0.866$), significant at the $P < 0.01$ level. The average plasma ^{131}I level in the males was greater than in females, but the difference was statistically significant only at the $P < 0.3$ level. The ^{131}I present after the fifth day in the plasma of the females was nearly all protein-bound. The plasma ^{131}I concentration initially was lower than in milk. On the contrary, after the fifth day, a higher radioactivity was noted in blood, probably because the plasma ^{131}I was nearly all protein-bound and less available for secretion in the milk. (BBB)

10702 THE ELIMINATION OF ^{131}I IN THE MILK OF SHEEP. Manunta, Giovanni; Marongiu, Antonio; Nuvole, Paolo (Univ., Sassari, Italy). Boll. Soc. Ital. Biol. Sper., 43: 513-15(May 31, 1967). (In Italian).

Secretion of radioiodine in sheep was studied because of the possibility of the entrance of this fallout radionuclide into the diet of sheep in areas where sheep milk is consumed, such as in Sardinia. Ten lactating ewes of the Sardinian breed, weighing ~35 Kg and 2 to 4 yr old, were given an oral dose of 104 μCi of $K^{131}I$ (carrier-free). The sheep were milked daily, and the level of ^{131}I in the milk was recorded. Between 3 and 30% of the administered dose was eliminated in the first milking (mean 17%). From the first to the fifth day the level of ^{131}I in milk dropped sharply and then leveled off; by the fifth day only ~0.1% of the administered dose was recovered in the milk. The mean percentage elimination by the fourth day was 20%. The total amount of ^{131}I recovered in the milk over the 46 day observation period was 22.3 ± 8.9%. Factors affecting milk levels of radioiodine in sheep are discussed. (BBB)

10703 EFFECT OF OXYGEN ON RADIATION-INDUCED FREE RADICALS IN PROTEINS. Henriksen, Thormod (Norwegian Radium Hospital, Oslo). Radiat. Res., 32: 892-904 (1967).

The effect of oxygen and nitric oxide on radiation-induced free radicals in trypsin was studied by ESR spectroscopy. Evacuated samples were x irradiated at room temperature and kept at this temperature for 20 hours before the ESR measurements started. The samples were then opened to an atmosphere of oxygen or nitric oxide, and the reactions between the paramagnetic gases and the protein radicals were followed by qualitative and quantitative ESR observations. The reaction with oxygen resulted in a transient ESR signal consisting of a single line with a g value of 2.007, and a width of approximately 13 gauss. This line is presumably due to a peroxide radical. In the case of nitric oxide nonradical products were directly formed. In experiments with nitric oxide and protein particles, with different physical dimensions, it was found that the decay of radicals can be adequately described by diffusion theory. It was found that the sulfur radicals as well as the doublet-type radicals react with the paramagnetic gases. (auth)

10704 THE MORPHOLOGY AND VITAL STAINING OF X-IRRADIATED ASCITES TUMOR CELLS. van Lessen, H.; Schuemmelfeder, N.; Bergeder, H. D. (Univ., Bonn). Z. Krebsforsch., 69: 309-15(1967). (In German).

Immediately following high-dose irradiation, the formation of blebs or blisters on the surface of Ehrlich ascites tumor cells was previously noted. This phenomenon, potocytosis, was investigated after a single high dose of x rays (20, 60, and 120 KR) in vitro on the MCa-1 strain of mouse ascites tumor cells by observing the formation of the cytoplasmic blebs and by staining the cells

with lissamine green, an acid vital stain. The extent of both potocytosis and uptake of vital dye that occurred after a latent period depended upon the radiation dose and the postirradiation storage temperature. The two phenomena represented two different stages of cell damage by x rays and could be identified as radiation damage only when similar morphologic changes, which sometimes develop during storage in vitro without previous irradiation, were avoided by suitable storage temperatures. (BBB)

10705 RANDOM DIFFERENCE EQUATIONS OCCURRING IN ONE-COMPARTMENT MODELS. Uppuluri, V. R. Rao; Feder, P. I.; Shenton, L. R. (Oak Ridge National Lab., Tenn. Stanford Univ., Palo Alto, Calif. Univ. of Georgia, Athens). Math. Biosci., 1: 143-71(1967).

For a single-compartment system, two models are studied with the object of finding the weakest assumptions under which one can draw the strongest possible conclusions about the limiting behavior to the random sequences involved. With constant pulsing and a random retention factor, Model I is given by $Y_0 = 1$ and $Y_n = 1 + X_nY_{n-1}$, $n = 1, 2, \ldots$, where Y_n denotes the amount in the compartment at the nth interval of time and X_n are independent identically distributed random variables. With random pulsing and a constant retention factor, Model II is given by $Y_0 = 1$ and $Y_n = W_n + \rho Y_{n-1}$, $n = 1, 2, \ldots$, where Y_n denotes the amount in the compartment at the nth interval of time and W_n denotes the random amount of material that enters the system at the nth step. The W_n are independent and identically distributed random variables and $\rho > 0$. (auth)

10706 ACTIVATION ANALYSIS. Brit. Med. J., 2: 509-10(Aug. 16, 1967).

Some new medical applications of activation analysis are reviewed. Thyroid metabolism, much studied by radioisotopes, can be studied by activation analysis. Semiautomatic methods for the routine determination of protein-bound stable iodine are elaborated, on the basis of the partial conversion, by thermal neutrons, of stable ^{127}I to ^{128}I. New prospects have resulted from the development of techniques using ^{129}I. The γ radiation emitted by ^{129}I results in a small radiation dose to the patient; therefore it is possible to obtain isotopic equilibrium in the body. The usefulness of ^{129}I is further enhanced by the fact that, on exposure to irradiation by thermal neutrons, it is partly converted to another radioisotope, ^{130}I and its isomeric form, ^{130m}I, allowing detection at excellent sensitivity by activation analysis. A technique entailing prior administration of ^{129}I, followed by neutron irradiation of the thyroid and simultaneous estimation (by external scintillation counting) of iodine-128, 130, and 130m, is described. The method provided an accurate estimate of thyroid iodine in animals and may soon be applicable to man. (BBB)

10707 INTERFERENCE BY NEAR ULTRAVIOLET AND GREEN LIGHT WITH MITOSIS IN THE ONION ROOT TIP MERISTEM. Wolff, Ellen G. (Fordham Univ., Bronx, N. Y.); Fives, Dorothy Marie; Klein, Richard M. Bull. Torrey Bot. Club., 94: 411-16(Sept.-Oct. 1967).

Near-ultra violet (365 nm) and green (546 to 577 nm) light irradiation suppressed mitosis in cells of the onion root tip meristem. As short a period of time as one hour of irradiation was sufficient to repress the mitotic index. Green radiations were less effective than the near-uv. Near-uv induced a relative increase in prophase mitotic figures and green light induced a relative increase in anaphase mitotic figures. Mitotic division in primary root tips of onion seedlings exhibited a diurnal rhythm with peaks of activity at noon and at midnight and secondary peaks at 7 AM and 7 PM. Irradiated roots did not deviate from this pattern. (BBB)

10708 A "STEM WELL" METHOD OF INTRODUCING RADIOISOTOPES INTO PLANTS TO STUDY FOOD CHAINS. Wiegert, Richard G. (Univ. of Georgia, Athens); Lindeborg, Robert G. Ecology, 45: 406-10(Spring 1964).

To study the transfer of materials through grazing food chains in herbaceous vegetation, a well surrounding the lower stem was used to introduce ^{59}Fe, ^{85}Sr, and ^{65}Zn into the vascular tissue. In most cases, after one week the radioisotopes from the wells were distributed throughout the above-ground parts of the plants. Iron-59 was uniformly distributed in the foliage of Johnson grass (Sorghum) and goldenrod (Solidago). Strontium-85 was distributed uniformly in Sorghum but remained concentrated in the stem of Solidago and did not move into the leaves. Recovery of the isotope applied in wells ranged from a high of 158% of that expected for ^{59}Fe in Sorghum to a low of 16% for ^{85}Sr in Sorghum. Movement was, in all cases, much greater than when isotopes were applied externally. Even when the overall recovery was low (as in ^{85}Sr applied to Sorghum) the well method produced much more uniform distribution throughout the above-ground portion of the plant than did foliar application. Zinc-65 moved laterally into the leaves near the point of application but its distribution in the upper portions of the plants was spotty. In sorrel (Rumex), however, ^{65}Zn moved to all portions of the plant above the well. The same radionuclides applied to the leaves did not move throughout the plant but remained concentrated at the points of application. (BBB)

10709 THE EFFECT OF THE LIGHT ON THE REDISTRIBUTION OF ^{90}Sr, ^{134}Cs, AND ^{65}Zn IN THE GERMINATING SEEDS OF SOYBEAN, (GLYCINE MAX (L) MERR.). Sudia, Theodore W.; Green, David G. (Univ. of Minnesota Agricultural Experiment Station, St. Paul). Plant Soil, 27: 103-12(Aug. 1967).

Redistribution of ^{90}Sr, ^{134}Cs, and ^{65}Zn in seeds of germinating soybeans growing in the light and dark was described. The ^{90}Sr translocated out of cotyledons and seed coats only to a slight extent, while ^{65}Zn and ^{134}Cs showed great mobility in movement from the storage organs of the seed to the growing parts. The seed coat of ^{90}Sr-treated plants, in contrast to the others, had a large amount of ^{90}Sr, as much as 20 to 30%. This was in comparison to 5% for ^{134}Cs-treated seeds and less than 5% for ^{65}Zn-treated seeds. While ^{90}Sr and ^{65}Zn did not appear to leave the seed coats, ^{134}Cs moved out of the seed coat to 100% depletion. In all cases light had an effect on the amount of materials translocated out of the cotyledons of soybeans, indicating that this effect must be related to the difference in growth and metabolism of seedlings growing in light and darkness. That great differences do exist in both situations was evident, from comparison of etiolated vs non-etiolated plants. (BBB)

10710 TRANSIENT INTERMEDIATES IN THE RADIOLYSIS OF HYALURONIC ACID. Balazs, E. A. (Retina Foundation, Boston); Davies, J. V.; Phillips, G. O.; Young, M. D. Radiat. Res., 31: 243-55(June 1967).

By means of electron paramagnetic resonance (EPR) after γ irradiation in the solid state, hyaluronic acid, glucuronic acid, and N-acetyl-glucosamine were found to have the following G (radicals), respectively: 3.7, 2.6, and 3.8. The EPR spectra of hyaluronic acid (at low dose) showed a doublet with hyperfine splitting of four to five gauss. Glucuronic acid after irradiation gave only a singlet that could not be further resolved. The intermediates satisfactorily account for the observed chemical degradation and EPR data. Pulse radiolysis of aqueous solutions, with 4 MeV electrons, showed that e^-_{aq} and OH radicals react rapidly with hyaluronic acid (HA), and the following rate constants (based on disaccharide repeating unit concentration) were found: $e^-_{aq} + HA \rightarrow k_2 = 3$ to $8 \times 10^8\ M^{-1}sec^{-1}$, $OH + HA \rightarrow k_2 = 8 \pm 0.4 \times 10^8\ M^{-1}sec^{-1}$. The susceptibility of hyaluronic acid to radiation damage is thus due to reaction with both major products of water radiolysis. In the solid state, hyaluronic acid behaves similarly to other polysaccharides on γ irradiation. (auth)

10711 IRRADIATION-INDUCED CHANGES IN THE DENATURATION TEMPERATURE AND INTERMOLECULAR CROSS-LINKING OF TROPOCOLLAGEN. Bailey, A. J. (Univ. of Cambridge, Eng. Agricultural Research Council, Cambridge, Eng.). Radiat. Res., 31: 206-14(June 1967).

The effect of ionizing radiations on the denaturation temperature and intermolecular cross-linking of solutions of tropocollagen was studied. A decrease in the denaturation temperature with increasing doses of radiation was observed by following the rapid change in optical rotation on collapse of the tropocollagen triple helix during subsequent heating. In addition to the thermally labile molecules, the presence of a proportion of undamaged molecules could be demonstrated at doses below 30 krads. At doses above 30 krads intermolecular cross-linking of the collagen molecules occurred as indicated by the formation of a gel, that at higher doses further cross-linked to form a completely insoluble material. The cross-linking reaction was found to be inhibited by the presence of oxygen or by the addition of a radical scavenger, suggesting an indirect mechanism due to the radiolysis products of water. (auth)

10712 EFFECT OF IRRADIATED SUCROSE ON CARBOHYDRATE METABOLISM OF CARROT CELLS. Faust, Miklos; Chase, Betty R.; Massey, L. M. Jr. (Cornell Univ., Geneva, N. Y.). Contract AT(30-1)-3274. Radiat. Res., 31: 201-5(June 1967).

The possible indirect effect of radiation through radiolysis of sucrose on carbohydrate metabolism of carrot cells was investigated. This was accomplished by study of the utilization of specifically labeled substrates in the presence of γ-irradiated aqueous sucrose. It was found that the presence of irradiated sucrose did not cause abnormality in the utilization of labeled glucose, acetate, or succinate. An apparent effect of irradiated sucrose on utilization of labeled glucose proved to be an artifact, probably due to radiolytic formation of glucose from sucrose. It was concluded that the Embden–Meyerhof–Paranas pathway, the pentose phosphate pathway, and the citric acid cycle of carrot

cells were not affected by the presence of irradiated sucrose. (auth)

10713 EFFECTS OF SKELETAL MUSCLE POTENTIATORS, INCLUDING URANYL IONS, ON CARDIAC MUSCLE. Nayler, Winifred G.; Price, Jocelyn M. (Baker Medical Research Inst., Melbourne). Amer. J. Physiol., 213: 1459-64(Dec. 1967).

The effect of skeletal muscle potentiators, including uranyl ions (UO_2^{++}), the substitution of Cl^- by NO_3^-, and caffeine, on contractions of amphibian and mammalian cardiac muscle was investigated. Uranyl ions (concentrations 5×10^{-4} M-5×10^{-8} M) did not potentiate cardiac muscle contractions. The addition of UO_2^{++} and the substitution of NO_3^- for Cl^- in K^+-enriched solutions bathing K^+-depolarized cardiac muscle failed to enhance contractures. The similar addition of caffeine enhanced K^+-induced contractures. The addition of caffeine to cardiac muscle bathed in or perfused with solutions containing NO_3^- instead of Cl^- resulted in potentiated contractions. These results are discussed with relation to the hypothesis that events involved in excitation-contraction coupling in cardiac muscle differ from those in skeletal muscle. (auth)

10714 EFFECT OF BETA IRRADIATION ON GANGLIONIC BIOELECTRIC ACTIVITY. Kaack, B. (Univ. of Notre Dame, Ind.). Amer. J. Physiol., 213: 1451-8(Dec. 1967).

Beta irradiation by ^{90}Sr produced a prompt enhancement of various bioelectric activities followed by a period of deterioration and ultimate block. Bioelectric activities involving cell bodies in the ganglion showed enhancement many times greater than activities involving only axons in the pretrunk or posttrunk. Under proper conditions this effect of irradiated ganglion cells on unirradiated parts of the preparation, as well as the effect of irradiated trunks on unirradiated ganglion-cell responses, was demonstrated. The conditions under which these effects could be produced were examined. (auth)

10715 AN ABC OF MODERN IMMUNOLOGY. VII. THE GENESIS OF IMMUNOLOGICAL COMPETENCE. Holborow, E. J. Lancet, 1: 1148-50(May 27, 1967).

Some radiobiological studies on the role of the thymus in lymphopoiesis are reported. Following lethal x irradiation, the lymphoid tissues of mice can be repopulated by injecting normal mouse bone marrow cells, and in radiation chimeras produced by this treatment the depleted thymus is also repopulated. Cell markers, particularly the abnormal radioinduced mouse chromosome translocation, T6, can be followed to trace cell migration into the thymus and other organs. Other experiments suggested that the cells that enter the thymus are derived from the bone marrow. By use of single and double marker chromosomes to identify lymph node cells and bone marrow cells respectively, a mixture of both were injected into lethally irradiated syngenic recipient mice. Two weeks later, the donor lymph node cells were dividing mainly in the recipients' lymph nodes, and the donor marrow cells in the marrow and spleen. The thymus also was undergoing repopulation by dividing cells, but these were almost entirely of bone marrow origin. When lymph node cells only were given, the lymph nodes became repopulated, but no marked cells appeared in the thymus. The myeloid cells are not immunologically competent, for bone marrow infusion does not itself usually restore immunological capability to lethally irradiated mice unless it is accompanied by an infusion of lymph node or spleen cells. Nevertheless, in such radiation chimeras, descendants of donor cells of myeloid origin at length replace the donor cells of lymphoid origin with which the recipients' lymph nodes are initially repopulated. The thymus must continue to function in adult life also in order to maintain an adequate pool of immunologically competent cells. In adult mice thymectomized and then sublethally x-irradiated, recovery of immune responsiveness is significantly less than in adult mice irradiated but not thymectomized. There are indications that lymphopoiesis in the thymus is not the same as induction of competence. When thymus grafts were irradiated in vitro at different doses before being transplanted into neonatally thymectomized mice, it was found that, whether they had received light or heavy irradiation, the grafts became repopulated with host lymphoid cells, and lymphopoiesis was re-established as readily as in nonirradiated grafts. However, while the recipients of lightly irradiated grafts regained immunological competence, recipients of heavily irradiated grafts did not. Thus the ability of thymic epithelial cells to foster lymphopoiesis may be distinct from their ability to engender immunological competence by means of a humoral factor. (BBB)

10716 EARLY ULTRASTRUCTURAL CHANGES IN EXPERIMENTAL GLIOMA FOLLOWING NEUTRON CAPTURE IRRADIATION. Nystrom, S. H. M. (Massachusetts General Hospital, Boston). Naturwissenschaften, 54: 341-2(1967).

Subcutaneously transplanted mouse ependymoblastomas of mice were exposed to ^{10}B neutron capture irradiation, fixed immediately, and embedded in various media for electron microscopic study of changes in tumor cell ultrastructure as compared with non-irradiated controls. The most striking changes in the irradiated tumors were found in the endothelium of the tumor blood vessel walls where long rows of clear intraendothelial vacuoles were observed. Extravasation of plasma and blood cells was abundant; the endoplasmic reticulum was occasionally swollen; and ribosomes were seen in compact groups. The early alterations appeared to be localized in the tumor cells as well as in the vessel walls. (C.H.)

10717 THE EFFECT OF GAMMA RAYS ON THE FINE STRUCTURE OF DEVELOPING PLASTIDS IN THE LEAVES OF ETIOLATED BEAN SEEDLINGS. Wrischer, M.; Devide, Z. (Inst. Rudjer Boskovic, Zagreb). pp 271-2 of Proc. Third Europ. Regional Conf. Electron Microscop., Prague, Aug. 26 to Sept. 3, 1964. Volume B. Prague, Publishing House of the Czechoslovak Academy of Sciences, 1964.

Shoot apices of etiolated bean seedlings (Top Crop variety) were γ irradiated (^{60}Co) with 10, 25, or 50 KR doses. The irradiated and nonirradiated plates (etiolated control) were then immediately exposed to continuous light for 48 hr and afterwards to a periodic illumination of 15 hr light and 9 hr darkness daily. Normal (non-etiolated) plants were grown under the same conditions (green control). Leaves of the irradiated and control plants were fixed for electron microscopy immediately before and 1, 3, 6, 24, 48 hr, and 9 days after the beginning of exposure to light. The γ-irradiated material fixed immediately before the exposure to light did not show any differences in comparison with etiolated control. Cells contained plastids with prolamellar bodies (crystalline centers) having a structure like a crystal lattice and only a few layers of vesicles. There was no difference in ultrastructure of plastids between γ-irradiated and nonirradiated material one hr after light exposure, both showing prolamellar bodies without any crystal-lattice-like structure and with radial or concentric layers of vesicles. After three- to six-hr of illumination the etiolated control showed the first grana, which were not found in the γ-irradiated material. After 24-hr continuous illumination, the chloroplasts of both materials contained parallel lamellae; but while there were numerous well developed grana in the etiolated control, in the γ-irradiated material there were only a few poorly developed ones depending on the dose used. These differences were even more striking 48 hr after irradiation. Nine days after exposure to light the chloroplasts of the etiolated control had a structure like that of the green control; the 10 KR-material was nearly like both controls, while the 24-KR and especially the 50-KR material showed a strikingly low number of grana. It was concluded that doses up to 50 KR did not inhibit the transformation of the crystal-lattice-like structure of the prolamellar bodies to the aggregates of alveoles and the development of the layers of vesicles. On the contrary, irradiation delayed and considerably inhibited the development of the grana and the corresponding sustained chlorophyll synthesis. (BBB)

10718 SEPARATION OF ^{131}I-INSULIN FRACTIONS RESULTING FROM RADIATION DAMAGE AND STUDY OF THEIR PROPERTIES. Kerp, L.; Steinhilber, S.; Kieling, F.; Sihler, K.; Hoffmann, G. (Univ., Freiburg i. B.). Nucl.-Med., 6: 159-69 (July 15, 1967). (In German).

Gel filtration of ^{131}I-labeled insulin on Sephadex G 50 and G 75 can be utilized for separation of intact insulin from radiation damaged insulin. Three radioactive components (component I, II, III) were separated. The quantity of damaged insulin in components I and III increased with specific radioactivity and the time after preparation of ^{131}I-labeled insulin. The behavior of radiation damaged insulin in gel filtration on Sephadex, ultracentrifugation, and precipitation by trichloracetic acid shows that component I corresponds to a damage product of high molecular weight, component III to split products of insulin of low molecular weight. Only the radioactive component II contains intact insulin that is bound by insulin-specific antibodies and possesses blood-sugar decreasing activity in intact mice. (auth)

10719 THE STUDY OF CALCIUM METABOLISM WITH RADIOACTIVE ISOTOPES. 1. GENERAL PRINCIPLES AND METHODS. Sack, H. (Univ., Munster, Ger.). Nucl.-Med., 6: 203-15(July 15, 1967). (In German).

The principles and methods of detecting the radioisotopes ^{45}Ca, ^{47}Ca, and ^{85}Sr are compiled and their significance in studies of calcium metabolism discussed. Problems of radiation dose are taken into account. The counting efficiency of various detectors is reported. For the simultaneous measurement of ^{45}Ca and ^{47}Ca in the same sample a new method is described which, in contrast to others, leads to results within two weeks. The counting instru-

ment used is a liquid scintillation spectrometer with a possibility of correcting for quenching, using a combination of the channels ratio and the external standards methods. (auth)

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Until recently it has not been possible to measure the respiratory rate of a fish in its natural environment, but it has been suggested that observed correlations between respiratory rate and rate of elimination of ^{65}Zn might be used for this purpose. The isotope is introduced into the water as chloride. The pattern of elimination of the isotope is shown; there was an initial rapid loss up to the 5th day, followed by a slower and approximately linear loss up to day 43, after which the isotope became stabilised within the body. Estimates were made of the amount of activity in different tissues, but the elimination mechanism was not determined. It was found that as the respiratory rate increased, so did the elimination rate. A plot of percentage elimination against respiratory rate appeared to be independent of temperature. Studies are described for fish in laboratory containers, in outdoor tanks, and in tanks on the sea bed. (UK)

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In experiments on rats into which $^{140}BaCl_2$ (5.18–8.04 μc) had been injected intravenously, elimination of the radioisotope from the animals was accelerated by osmotic diuresis produced by continuous intravenous injection, usually for 6 hrs, of an 0.09 M Na_2SO_4 solution to which K_2SO_4, $CaCl_2$, and $MgSO_4$ had been added to compensate for electrolyte losses. Continuous injection of Na_2SO_4 was more effective than its injection in a single dose of 150 mg per rat. Injection of DTPA in a single dose 100 μmole per rat was less effective than that of Na_2SO_4 applied as a continuous or single injection in expediting the elimination of ^{140}Ba, while injection of DEETA was still less effective. The sequestering agents or Na_2SO_4 applied in a single injection accelerated elimination of ^{140}Ba only when applied within the first 30 minutes after introduction of the isotope. Because of the low concentration of barium, kidney deposition of $BaSO_4$ from the reaction of Ba^{++} with Na_2SO_4 did not take place. (auth)

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The ability of uranyl and thorium ions to protect baker's yeast cells against lysis by various types of cytolytic agents was studied by conductivity measurements. Both uranyl and thorium ions were effective in preventing cytolysis by Toluidine Blue and Azure A because they interfered with dye uptake by the cells. Neither uranyl nor thorium ions prevented the uptake of cetrimide or cetylpyridinium chloride. Cetylpyridinium chloride was capable of releasing previously bound uranyl ions from the cell surface. Anionic groups belonging to lipid constituents of the cell membrane may be involved in the uptake of uranyl and thorium ions as well as in the binding of dye and surfactant cations respectively. Possible cytolytic mechanisms involving polar interactions at the cell surface with lytic cations are discussed. (BBB)

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Large increases of plant growth have been observed in irradiated soils, and experiments consistently showed substantial increases in nitrate content in fresh soils after treatment with 1.5 to 200×10^3 R. In order to establish the point at which oxidation of ammonium to nitrate begins to be diminished by irradiation the soils were treated with increasing doses up to 1×10^6 R. It was found that nitrite accumulated rapidly in some, but not all, soils. The nitrite was determined by a modified Griess-Ilosvay technique. Experimental details are described, and results are shown graphically. Two principal mechanisms were considered possible: first, a blockage of the nitrite oxidation process in Nitrobacter, or second, reduction of nitrate. High soil moisture greatly enhanced nitrite accumulation. Experiments were made to determine whether accumulated ammonium or nitrate nitrogen was the source of nitrite. It was concluded that nitrate reduction was the principal mechanism. No nitrite toxicity to plants was observed. It is considered improbable that proliferating organisms are involved in the nitrogen transformations above 5×10^5 R, but it is noted that bacterial enzymes are very radioresistant and can remain active in non-proliferating cells. The findings of other workers are discussed. (UK)

10732 COMPARATIVE STUDIES ON THE INDUCTION OF TRANSPLANTATION RESISTANCE IN BALB/c AND C57BL/6 MICE IN THREE MURINE LEUKEMIA SYSTEMS. McCoy, J. L. (Microbiological Associates, Inc., Bethesda, Md.); Fefer, A.; Glynn, J. P. Contract PH-43-64-911. Cancer Res., 27: 1743-8(Oct. 1967).

Syngeneic x-irradiated Friend, Moloney, and Rauscher (FMR) lymphomas readily induce transplantation resistance in C57BL/6 mice. Similar resistance is more difficult to induce in BALB/c mice. To determine whether this difference in response is due to a lesser immunogenicity of FMR cells of BALB/c origin, C57BL/6 mice were pretreated with viable or x-irradiated BALB/c FMR cells, or with x-irradiated C57BL/6 FMR cells, and were challenged with FMR lymphomas of C57BL/6 origin. The reverse experiments were performed in BALB/c recipients. All FMR lymphomas of both strains induced strong transplantation resistance in C57BL/6 mice. Therefore, FMR lymphomas of BALB/c origin were immunogenic in C57BL/6 mice. However, FMR cells of either strain generally induced only weak or nondetectable resistance in BALB/c mice. X-irradiated FMR lymphomas of both strains released varying amounts of infectious virus when inoculated into BALB/c newborns. Lymphomas releasing lesser amounts of virus were usually the more effective immunogens for the induction of transplantation resistance in BALB/c mice. It was therefore postulated that BALB/c mice were less able than C57BL/6 mice to handle immunologically large quantities of virus. This was substantiated by the markedly greater susceptibility of weanling BALB/c mice than C57BL/6 mice to Rauscher virus, as judged by the induction of splenic enlargement, viremia and death. It is suggested that the inoculation of highly susceptible BALB/c mice with lymphomas that release large quantities of virus may impede or obscure specifically or nonspecifically the immunologic reactivity to a subsequent tumor challenge. (auth)

10733 NUCLEOLAR BEHAVIOR IN REGENERATING LIVER OF NORMAL AND WHOLE-BODY-IRRADIATED RATS. Mironescu, St.; Dragomir, C. (Inst. of Oncology, Bucharest). Cancer Res., 27: 1819-30(Oct. 1967).

After partial removal of the liver in Wistar rats, the number of nucleoli in hepatocytes was found to be substantially reduced, especially in the periods preceding the outburst of mitoses. By delaying the appearance of mitotic waves by whole-body x-irradiation (1000 R) delivered prior to surgery, a more pronounced lowering of the nucleoli number was observed. Following each mitotic peak, developed within the first 50 hours after operation, the normal distribution of different nucleolar number categories was regained. With respect to the mechanism of this numerical reduction, some evidence is presented, indicating that either the whole or parts of nucleoli may be extruded in the extranuclear areas of regenerating liver cells. Planar measurements demonstrated an important nucleolar volume enlargement, that took place particularly in the whole-body irradiated animals. The specific cytochemical tests employed showed that the intranucleolar structures containing RNA and/or lysine-rich proteins increased in both number and size, predominantly after x-irradiation followed by partial hepatectomy, exceeding by far the amounts observed in unirradiated liver cell nucleoli. The internal structure of nucleoli, as revealed by toluidine blue-ammonium molybdate staining procedures, Methods A or B, was modified after whole-body irradiation, owing to the development of anisonucleolinosis. Some possible mechanism that could be involved in the numerical reduction and/or nucleolar enlargement phenomena, as well as those incriminated in the appearance of anisonucleolinosis, are suggested and discussed. (auth)

10734 ANTIGENIC COMPETITION: CELLULAR OR HUMORAL. Radovich, Jevrosima; Talmage, David W. (Univ. of Colorado Medical Center, Denver). Science, 158: 512-14 (Oct. 27, 1967).

The injection of one antigen into mice inhibited the response to a second when one to 10 days separated the two injections. When the same type of inhibition was attempted in γ-irradiated mice reconstituted with normal spleen cells, the inhibition was greater in mice receiving 50 million spleen cells than in those receiving 10 million. The results are interpreted as favoring a humoral mechanism of inhibition. (auth)

10735 A NEW APPROACH TO CHEMOTHERAPY AND RADIOTHERAPY OF CANCER. Sahasrabudhe, M. B. (Indian Cancer Research Centre, Parel, India). J. Sci. Ind. Res., 26: 243-8(June 1967).

Although acceleration of hexose monophosphate (HMP) metabolism is not an essential prerequisite for the initiation of malignancy, it is essential for the maintenance of rapid growth in most of the rapidly growing tumors. In an attempt to preferentially interfere with the tumor growths, over 80 antimetabolites of HMP pathway intermediates were synthesized and screened for anticancer activity. The results of the screening tests are reviewed. Seven of these antimetabolites tested, viz. thiophene-2,5-dicarboxylic acid (TDA), 2,5-dimercaptomethylthiophene (MMT), thiouronium derivative of 2,5-dimercaptomethylthiophene (TUMMT), and 2,5-dicarbethoxy-3,4-dihydroxythiophene (DICETOL), thio-

ment used is a liquid scintillation spectrometer with a possibility of correcting for quenching, using a combination of the channels ratio and the external standards methods. (auth)

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The ability of uranyl and thorium ions to protect baker's yeast cells against lysis by various types of cytolytic agents was studied by conductivity measurements. Both uranyl and thorium ions were effective in preventing cytolysis by Toluidine Blue and Azure A because they interfered with dye uptake by the cells. Neither uranyl nor thorium ions prevented the uptake of cetrimide or cetylpyridinium chloride. Cetylpyridinium chloride was capable of releasing previously bound uranyl ions from the cell surface. Anionic groups belonging to lipid constituents of the cell membrane may be involved in the uptake of uranyl and thorium ions as well as in the binding of dye and surfactant cations respectively. Possible cytolytic mechanisms involving polar interactions at the cell surface with lytic cations are discussed. (BBB)

10731 ACCUMULATION OF NITRITE IN FRESH SOILS AFTER GAMMA IRRADIATION. Cawse, P. A. (United Kingdom Atomic Energy Authority, Wantage, Eng.); Crawford, D. V. Nature (London), 216: 1142-3(Dec. 16, 1967).

Large increases of plant growth have been observed in irradiated soils, and experiments consistently showed substantial increases in nitrate content in fresh soils after treatment with 1.5 to 200×10^3 R. In order to establish the point at which oxidation of ammonium to nitrate begins to be diminished by irradiation the soils were treated with increasing doses up to 1×10^6 R. It was found that nitrite accumulated rapidly in some, but not all, soils. The nitrite was determined by a modified Griess-Ilosvay technique. Experimental details are described, and results are shown graphically. Two principal mechanisms were considered possible: first, a blockage of the nitrite oxidation process in Nitrobacter, or second, reduction of nitrate. High soil moisture greatly enhanced nitrite accumulation. Experiments were made to determine whether accumulated ammonium or nitrate nitrogen was the source of nitrite. It was concluded that nitrate reduction was the principal mechanism. No nitrite toxicity to plants was observed. It is considered improbable that proliferating organisms are involved in the nitrogen transformations above 5×10^5 R, but it is noted that bacterial enzymes are very radioresistant and can remain active in non-proliferating cells. The findings of other workers are discussed. (UK)

10732 COMPARATIVE STUDIES ON THE INDUCTION OF TRANSPLANTATION RESISTANCE IN BALB/c AND C57BL/6 MICE IN THREE MURINE LEUKEMIA SYSTEMS. McCoy, J. L. (Microbiological Associates, Inc., Bethesda, Md.); Fefer, A.; Glynn, J. P. Contract PH-43-64-911. Cancer Res., 27: 1743-8(Oct. 1967).

Syngeneic x-irradiated Friend, Moloney, and Rauscher (FMR) lymphomas readily induce transplantation resistance in C57BL/6 mice. Similar resistance is more difficult to induce in BALB/c mice. To determine whether this difference in response is due to a lesser immunogenicity of FMR cells of BALB/c origin, C57BL/6 mice were pretreated with viable or x-irradiated BALB/c FMR cells, or with x-irradiated C57BL/6 FMR cells, and were challenged with FMR lymphomas of C57BL/6 origin. The reverse experiments were performed in BALB/c recipients. All FMR lymphomas of both strains induced strong transplantation resistance in C57BL/6 mice. Therefore, FMR lymphomas of BALB/c origin were immunogenic in C57BL/6 mice. However, FMR cells of either strain generally induced only weak or nondetectable resistance in BALB/c mice. X-irradiated FMR lymphomas of both strains released varying amounts of infectious virus when inoculated into BALB/c newborns. Lymphomas releasing lesser amounts of virus were usually the more effective immunogens for the induction of transplantation resistance in BALB/c mice. It was therefore postulated that BALB/c mice were less able than C57BL/6 mice to handle immunologically large quantities of virus. This was substantiated by the markedly greater susceptibility of weanling BALB/c mice than C57BL/6 mice to Rauscher virus, as judged by the induction of splenic enlargement, viremia and death. It is suggested that the inoculation of highly susceptible BALB/c mice with lymphomas that release large quantities of virus may impede or obscure specifically or nonspecifically the immunologic reactivity to a subsequent tumor challenge. (auth)

10733 NUCLEOLAR BEHAVIOR IN REGENERATING LIVER OF NORMAL AND WHOLE-BODY-IRRADIATED RATS. Mironescu, St.; Dragomir, C. (Inst. of Oncology, Bucharest). Cancer Res., 27: 1819-30(Oct. 1967).

After partial removal of the liver in Wistar rats, the number of nucleoli in hepatocytes was found to be substantially reduced, especially in the periods preceding the outburst of mitoses. By delaying the appearance of mitotic waves by whole-body x-irradiation (1000 R) delivered prior to surgery, a more pronounced lowering of the nucleoli number was observed. Following each mitotic peak, developed within the first 50 hours after operation, the normal distribution of different nucleolar number categories was regained. With respect to the mechanism of this numerical reduction, some evidence is presented, indicating that either the whole or parts of nucleoli may be extruded in the extranuclear areas of regenerating liver cells. Planar measurements demonstrated an important nucleolar volume enlargement, that took place particularly in the whole-body irradiated animals. The specific cytochemical tests employed showed that the intranucleolar structures containing RNA and/or lysine-rich proteins increased in both number and size, predominantly after x-irradiation followed by partial hepatectomy, exceeding by far the amounts observed in unirradiated liver cell nucleoli. The internal structure of nucleoli, as revealed by toluidine blue-ammonium molybdate staining procedures, Methods A or B, was modified after whole-body irradiation, owing to the development of anisonucleolinosis. Some possible mechanism that could be involved in the numerical reduction and/or nucleolar enlargement phenomena, as well as those incriminated in the appearance of anisonucleolinosis, are suggested and discussed. (auth)

10734 ANTIGENIC COMPETITION: CELLULAR OR HUMORAL. Radovich, Jevrosima; Talmage, David W. (Univ. of Colorado Medical Center, Denver). Science, 158: 512-14 (Oct. 27, 1967).

The injection of one antigen into mice inhibited the response to a second when one to 10 days separated the two injections. When the same type of inhibition was attempted in γ-irradiated mice reconstituted with normal spleen cells, the inhibition was greater in mice receiving 50 million spleen cells than in those receiving 10 million. The results are interpreted as favoring a humoral mechanism of inhibition. (auth)

10735 A NEW APPROACH TO CHEMOTHERAPY AND RADIOTHERAPY OF CANCER. Sahasrabudhe, M. B. (Indian Cancer Research Centre, Parel, India). J. Sci. Ind. Res., 26: 243-8(June 1967).

Although acceleration of hexose monophosphate (HMP) metabolism is not an essential prerequisite for the initiation of malignancy, it is essential for the maintenance of rapid growth in most of the rapidly growing tumors. In an attempt to preferentially interfere with the tumor growths, over 80 antimetabolites of HMP pathway intermediates were synthesized and screened for anticancer activity. The results of the screening tests are reviewed. Seven of these antimetabolites tested, viz. thiophene-2,5-dicarboxylic acid (TDA), 2,5-dimercaptomethylthiophene (MMT), thiouronium derivative of 2,5-dimercaptomethylthiophene (TUMMT), and 2,5-dicarbethoxy-3,4-dihydroxythiophene (DICETOL), thio-

diglycollic acid (TGDA), thiodiglycol (TDGOL), and thiodipropionic acid (TDPA), showed anticancer activity in experimental chemotherapy of cancer; with four of these, viz. TUMMIT, TDGA, TDGOL, and TDPA, complete cures of Yoshida sarcoma in mice were achieved. Since the margin of safety between therapeutic effectiveness and toxicity is fairly wide, two compounds, DICETOL and TDGA, were tried clinically in advanced and incurable cases of cancers, and tumor growth appeared to be arrested as long as the treatment lasted. One of the major handicaps in radiotherapy of cancer is the poor vascularity of tumor mass, that renders the tumor cells comparatively deficient in oxygen and, therefore, insensitive to radiation damage. Increased availability of free oxygen in the tumor mass is achieved by interfering with the utilization of oxygen through HMP pathway. A combination of pretreatment with antimetabolites of HMP pathway followed by radiation exposures was shown to increase the radiosensitivity of tumor cells considerably. (auth)

10736 UPTAKE OF PLUTONIUM IN BONE MARROW: A POSSIBLE LEUKAEMIC RISK. Vaughan, Janet; Bleaney, Betty; Williamson, Margaret (Churchill Hospital, Oxford). Brit. J. Haematol., 13: 492-502(July 1967).

Observations are reported on the pattern of distribution of ^{239}Pu and of the radiation dose received in the bone marrow of the femur of young rabbits given a single injection of $^{239}Pu(NO_3)_4$, and killed at subsequent time intervals. The total amount of plutonium in the marrow falls by a factor of about 30 between 1 day and 7 months after injection. Initially, there are localized deposits of plutonium, largely in macrophages containing an iron-containing pigment. There is also a diffuse distribution. The diffuse distribution falls off with time after injection, and at 7 months there are predominantly localized deposits of plutonium. These contain about one-fifth of the amount of plutonium seen in deposits 24 hours after injection. It is likely that any cell actually containing a plutonium atom will be killed at decay owing to the intense localized energy of the alpha track but adjacent cells may well receive a lower radiation dose that will result in cell damage and subsequent possible carcinogenic change. Osteosarcoma is known to result from single intravenous injections of $^{239}Pu(NO_3)_4$ but leukaemia has resulted from repeated intravenous injections. The results described in this paper are consistent with these observations. They suggest that marrow retention should be considered in determining maximum permissible levels of this radionuclide. Plutonium retained in the marrow will irradiate both haemopoietic and osteogenic cells. (auth)

10737 SUBMICROSCOPIC STRUCTURE OF SPRUCE TRACHEIDS FORMED UNDER THE INFLUENCE OF GAMMA RADIATION. Odintsov, P.; Katkevich, Yu. (Inst. of Wood Pulp Chemistry, Riga). Latv. PSR Zinat. Akad. Vestis, No. 7, 70-5 (1967). (In Russian).

Electron microscopic investigations were made of spruce tracheids, irradiated during growth with γ radiation and stained for pectin during different stages of delignification. The studies indicated an increased quantity of pectin materials in the secondary wall of the irradiated tracheids. The secondary wall has a porous structure. In delignification of unirradiated walls, bonds of a carbohydrate character are observed between adjacent primary walls. The secondary walls of chlorcellulose show a nonregular lamellar structure. The lamellae in the secondary walls are connected by microfibrillar bonds. Ionizing radiation causes changes in the formation of lamellar structure of the cellulose in the secondary walls. (tr-auth)

10738 EFFECT OF RADIATION AND RADIOPROTECTORS ON LYSOSOMAL AND OTHER ENZYMES. Noaman, Mohamed Ahmed-Attia. Athens, Ga., Univ. of Georgia, 1966. 349p. Thesis.

Whole-body γ irradiation of white male rats with 750 γ (= LD_{50}) enhanced, in general, the activities of the lysosomal enzymes (acid phosphatase, muramidase, β-galactosidase, β-glucuronidase, arylsulfatase acid RNAase and DNAse U) of brain, heart, liver, and small intestine in the first three days post-irradiation. However, the extent of the increases of these enzymes as a function of time differed from one enzyme to the other and also from one tissue to another. In the brain tissues, irradiation enhanced the activities of all the lysosomal enzymes except acid phosphatase, whereas in the heart tissues, arylsulfatase was the only lysosomal enzyme that did not increase its activity at any time post-irradiation. The activities of β-galactosidase, β-glucuronidase and arylsulfatase increased in liver. In the small intestine, all of the lysosomal enzymes except acid phosphatase and β-glucuronidase increased due to irradiation. Within two to six days post-irradiation, activities of lysosomal enzymes decreased except for heart's acid RNAase, liver's acid phosphatase and small intestine's muramidase, β-glucuronidase and arylsulfatase. These changes may be due to release of enzymes from lysosome particles and to many secondary disturbances in the irradiated animal's cellular metabolism. It seems that there may be at least four kinds of lysosome particles (α, β, γ and δ lysosome) with different degrees of radiosensitivity and that each type of lysosome particle has some, but not all, of the lysosomal enzymes and that these kinds are different with respect to enzyme present in the particles and also different with respect to the organs. Alkaline phosphatase activity increased three hours to six days post-irradiation in all four organs examined but decreased two to three days depending on the organs. The ATPase activity decreased three hours post-irradiation in all four organs and increased thereafter in heart, liver and small intestine. In vitro studies revealed that muramidase was radiosensitive whereas the acid phosphatase was radioresistant. The acid RNAase and DNAase 11 had a D_{37} of less than 10,000 rads. Alkaline phosphatase, β-glucuronidase and arlysulfatase had a D_{37} value of less than 20,000 rads. D_{37} for ATPase and β-galactosidase was 52,500 and 60,000 rads, respectively. Cysteine to the extent of 0.1 mM exhibited a pronounced radioprotective effect toward all the enzymes examined except β-glucuronidase. The D_{37} of the enzymatic activity increased fourfold for muramidase, two-fold for the arylsulfatase and apyrase and one to two times for alkaline phosphatase, acid phosphatase and β-galactosidase. Addition of unirradiated cysteine or unirradiated or 4AIN irradiated enzyme more or less restored the enzymatic activity, but this effect was less pronounced than that of irradiated enzyme in the presence of radioprotectors. Addition of irradiated radioprotectors to unirradiated enzyme was without effect. Some inhibitory effect was noted upon the addition of cysteine to all the enzymes except β-glucuronidase before irradiation. The latter showed increases in activity. However, 4AIN increased the activity of β-glucuronidase and DNAase II and partially inhibited the other enzymes except for β-galactosidase. (Disser. Abstr.)

Ecology

Refer also to abstracts 10674, 10773, and 10776.

10739 (BNWL-480, pp 127-51) ENVIRONMENTAL RADIATION STUDIES: TERRESTRIAL. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Radioecological studies of the accumulation of ^{137}Cs along the lichen-caribou-Eskimo food chain, the Hanford Reservation and surrounding areas, radioisotope mobility in ecosystems, and the uptake of radioisotopes of cesium, lead, and iodine by plants are reported. Preliminary results of studies of the effects of radiation on growth and dormancy of potato tubers are discussed. (E.R.B.)

10740 (BNWL-480, pp 153-93) ENVIRONMENTAL RADIATION STUDIES: AQUATIC. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Radioactive contamination of aquatic environments by nuclear research and production sources is considered with particular reference to effects of the Hanford operation on the biota of the Columbia River. Increasing concern over the pollution (nuclear and otherwise) of water resources is evident. Research is reported on: basic studies concerning temperature stresses in fish; the effects of radioisotopes, temperature, and other environmental factors on the biota in the Columbia River; and the potential radiation hazards to users of the fresh water facilities at the proposed nuclear excavation sites in Colombia and Panama. (E.R.B.)

Genetics and Cytogenetics

Refer also to abstracts 10778, 10835, 10869, 10881, 10886, 10889, and 10895.

10741 THE EFFECTS OF X-RAY IRRADIATION ON SELECTION RESPONSE IN DROSOPHILA MELANOGASTER. Kitagawa, Osamu (Tokyo Metropolitan Univ.). Nippon Idengaku Zasshi, 42: 121-37(Apr. 1967).

Experiments were performed to clarify the mechanism by which new genetic variability available for artificial selection was induced by x rays, and to estimate the increase of polygenic variability in abdominal bristle numbers of Drosophila. The total number of bristles on the fourth and fifth abdominal plates was selected in both high and low directions. The response of hybrid strains (Oregon R × Samarkand) was generally higher than that of pure strains (Oregon-R), presumably because the hybrid ones had higher genetic variability at the start of the experiment. Genetic variability, probably originating from mutation and recombination in polygenic systems, was induced by irradiation, and contributed

to the effectiveness of artificial selection. From the variance analysis, the grade of response of each lot was ranked as follows: both sexes treated = only males treated > only females treated > both sexes untreated. The possible difference in effectiveness between induced mutation and induced recombination is discussed. The mutation rates induced by x rays, in terms of increments of variance, were estimated from the selection responses. They were 28.1×10^{-5} (both sexes treated), 10.7×10^{-5} (only females treated), and 20.3×10^{-5} (only males treated) per unit dose. (BBB)

10742 RADIATION-INDUCED LOSS OF REPRODUCTIVE INTEGRITY IN THE STAMEN HAIRS OF A POLYPLOID SERIES OF TRADESCANTIA SPECIES. Ichikawa, S.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 7: 429-41(Oct, 1967). (BNL-11500).

Stamen hairs of a polyploid series consisting of Tradescantia clone 02 (2x = 12), T. virginiana, T. rosea, T. crassifolia (all 4x = 24) and T. blossfeldiana (12x = 72) were found to be essentially single-meristematic-cell systems. Inflorescences of the latter four species were exposed to ^{137}Cs γ-rays. Stamen hairs from irradiated and control inflorescences were observed daily for up to 27 days after irradiation. The periods when the maximum radiation effects could be seen were species-, position-, and exposure-dependent. The exposure-dependent appearance of the radiation effects, generally later for higher exposures, indicated that mitotic delay and slowed cell division were involved. The D_{37} value was determined for the terminal cells of the stamen hairs for each species, based on the frequency of occurrence of stunted hairs (those which had lost their reproductive integrity). The values obtained, 360 R for T. virginiana, 527 R for T. rosea, 675 R for T. crassifolia, 1880 R for T. blossfeldiana, and 270 R for Tradescantia clone 02 determined previously, were found to be inversely proportional to the interphase chromosome volumes of young stamen hair cells. Therefore, the differences in the D_{37}s are best explained by the reduced target volumes of the chromosomes in these polyploids and not by genetic redundancy. The absorbed energy per chromosome at D_{37} was calculated for all five species and was found to be relatively constant, supporting the above conclusion. (auth)

10743 THE MUTAGEN-ACTIVE INFLUENCE OF RADIOACTIVE PHOSPHORUS (^{32}P) ON DACTYLIS GLOMERATA LEMBA R.V.P. (CONTINUATION). de Loose, R. (Proefstation voor Veredeling der Landbouwgewassen, Lemberge, Belg.). Landbouwtijdschrift, 16: 949-63(June 1963). (In Flemish).

The mutagenic effect of ^{32}P on cocksfoot seeds and shoots was studied. The LD_{50} was about 40 μCi/ml uptake over a six-week-period; inactive P_2O_5 was added after four weeks. In the M_1 generation different chlorophyll striata chimeras were observed at frequencies of 0% to 14%. The M_2 inbred generation had a total outsplitting value of 19% of the M_1 progeny for chlorophyll mutants; in individual cases this reached 41%. For the total of M_2 plants the value was 6.86% in the most favorable cases. In the M_3 generation the value rose to 33.1%. Of a total of 1869 inbred shoots in the M_2 and 5289 in the M_3, none were found completely free from silicic acid indentations; neither were any found free in cross-pollinated M_2 and M_3 seeds and shoots. (BBB)

10744 VIABILITY COEFFICIENTS AND PREFERENTIAL RECOVERY. Falk, Raphael (Hebrew Univ., Jerusalem). Mutat. Res., 4: 821-30(Nov.-Dec. 1967).

The proportion of Drosophila melanogaster progeny heterozygous for two marked balancer chromosomes varied in reciprocal matings. Preferential segregation of the marker chromosomes, either in females or in males, was suspected. When x-irradiated chromosomes were transmitted to progeny by their fathers the induced mutations appeared to give heterotic effects. The effects were, however, detrimental when the irradiated chromosomes were transmitted to the progeny by their mothers. This difference was ascribed to slight preferential segregation caused in males by many of the induced detrimental mutations. (auth)

10745 FITNESS OF HETEROZYGOTES FOR IRRADIATED CHROMOSOMES IN DROSOPHILA. Falk, Raphael (Hebrew Univ., Jerusalem). Mutat. Res., 4: 805-19(Nov.-Dec. 1967).

Artificial populations of Drosophila melanogaster were established in small plastic containers. Each population was started with equal numbers of flies heterozygous for a Curly-chromosome and a given irradiated chromosome and flies heterozygous for the same Curly-chromosome and an unirradiated chromosome. Since the homozygotes were either lethal or sterile, only fitness of the heterozygotes for the irradiated chromosome and of the heterozygotes for the unirradiated chromosome determined the fate of the populations. The populations were sampled periodically and the frequency of each genotype was determined. The viability coefficients of the homozygotes and heterozygotes of the irradiated and unirradiated chromosomes were determined prior to the establishment of the populations. These coefficients were determined again for those chromosomes that were retained for nearly one year in the populations. In one experiment more than 240 populations were started with chromosomes that had been exposed in spermatozoa to 2000 R of x radiation. Most populations were maintained for 3 to 4 months. In the second experiment more than 200 populations were started with chromosomes that had been exposed in spermatogonia to four doses of 3000 R each. Most populations were maintained for seven months, and those not heterozygous for lethals were maintained for another five months. A third, control experiment, included only non-irradiated chromosomes. In both radiation experiments the fitness of heterozygotes for irradiated chromosomes was below unity fitness. It did not deviate from unity in the control experiment. The mean fitness of heterozygotes for lethals was reduced by about 7% per generation. Subvitals were defined so that they overlapped the normal range, yet their fitness in heterozygotes was reduced by about 2% per generation. Normal chromosomes in the irradiated samples did not deviate from unity fitness. The results show that on the average the fitness of the heterozygotes for a sample of newly induced mutations is correlated to the viability of the homozygotes. This is also demonstrated by the improvement in the viability of the homozygotes for chromosomes, which were originally subvital, after these were exposed for nearly one year to selection as heterozygotes. (auth)

10746 THE DIFFERENT SENSITIVITY OF THE GENOMES OF OENOTHERA BERTERIANA AGAINST ETHYL METHANESULFONATE. Kressel, M.; Arnold, C. G. (Univ., Erlangen, Ger.). Mutat. Res., 4: 797-804(Nov.-Dec. 1967). (In German).

Oenothera berteriana is a complex heterozygote species with genome complexes named B and 1. Egg and sperm cells were treated with ethyl methanesulfonate. Thereafter self-pollination was carried out. Because both genomes may be mutated by the mutagen, the genetic constitution of the M_1-mutants was termed B′ and 1′, respectively. These mutants were crossed to plants that carried in the pollen either the B or 1 complex. Because there were no homozygous forms, crossing of B′.1′ × B yielded B.1′ plants and crossing of B′.1′ × 1, only B′.1 plants. Thus it was possible to compare the EMS sensitivity of the genomes. It was found that the genome complex 1 was considerably more sensitive to EMS than was the genome complex B. This agreed with the findings after x irradiation. It was shown by experiments with x rays that the different sensitivity of the two genomes was caused by a different chromosome mutation rate; aberrations were more often induced in chromosomes of the 1-complex than in chromosomes of the B-complex. This higher sensitivity of the 1-genome for x rays and EMS was presumably caused by small, scarcely visible, deficiencies. Translocations could not account for this phenomenon, since they did not appear after EMS treatment in Oenothera berteriana. The translocations that often can be found after x irradiation are, however, important for the appearance of trisomic plants in the X_2-generation for the frequency of non-disjunction is raised by these translocated chromosomes. Since EMS did not cause translocations, there were no trisomic plants in the M_2-generation. (auth)

10747 LETHAL SECTORING AND THE ORIGIN OF COMPLETE MUTANTS IN SCHIZOSACCHAROMYCES POMBE. Auerbach, C. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 4: 875-8(Nov.-Dec. 1967).

An examination was made of the lethal-hit hypothesis that postulates that mutagens presumed to attack single strands of DNA yield complete mutants when a non-mutated strand of DNA opposite a mutated one is knocked out by an adventitious legal hit. The analysis was done on the expected proportions of mutations of Schizosaccharomyces pombe from cultures that were exposed to different doses of uv radiation. Some surviving cells gave rise to two-colony forming cells at the first postirradiation division, while others gave rise to only one-colony forming cell; cells that died were referred to as lethal-sector type cells (type S-cells). The type-S cells were supposed to transform potentially mosaic mutations into complete ones. It was shown that uv radiation did not usually kill cells of S. pombe by two lethal hits on opposite strands of DNA; doubt was also thrown on the origin of lethal sectors after a study was made of survival curves. It was concluded that killing, as well as production of lethal sectors, was caused by lethal hits on individual DNA strands. Only a portion of complete mutants was considered to be caused by lethal sectoring; other factors were considered to be responsible for the remainder. (F.M.M.)

10748 THE ACTION OF UV ON GENETIC RECOMBINATION IN DROSOPHILA MELANOGASTER OOGONIA. Proust, Jacqueline (Faculte des Sciences, Orsay, France). Mutat. Res., 4: 837-63(Nov.-Dec. 1967). (In French).

Results concerning the action of uv radiation on genetic recombination in females of Drosophila melanogaster are presented. Ovaries that were irradiated in vitro were injected into the body cavity of larvae. This technique was used since it allowed good penetration of uv rays through the gonad. Four experiments were performed and seven different exposure levels were used. Recombination was studied between (a) genes b pr located near the centromere on chromosome II (exposure: 820 ergs/mm^2); (b) genes al, dp, c, px also on chromosome II (exposure: 1500 ergs/mm^2); (c) genes y, cv, f on the X chromosome, (exposure: 1000, 15000, 2000, and 3000 ergs/mm^2); (d) closely linked genes th, st, and cp located adjacent to the centromere on the third chromosome (exposures: 500, 1500, and 2500 ergs/mm^2). The data showed that uv irradiation increased the meiotic recombination frequency and that uv irradiation produced some anomalies in the segregation of the genes under study. Investigation of these anomalies indicated that disjunction of each pair of alleles in the irradiated sample was not different from the control. However, comparisons between the individual progenies were very heterogenous. The extent of this heterogeneity varied with the position of the gene along the chromosome. The region where the heterogeneity was maximum were called hot regions. When the segregation of two genes was investigated, it appeared that the recombination frequency was increased. This increase was particularly important for closely linked genes located near the centromere. Evidence from this study indicated that somatic recombinations were induced in oogonia, however, these recombinations were not as symmetrical as crossing over. They resembled a process similar to conversion observed in fungi. In fact, an absence of correlation was observed between the frequencies of reciprocal cross-over classes and no systematic association existed between a cross-over and a non cross-over class. The maximum dose of effectiveness was located around 1500 ergs/mm^2. The nature of the delayed mechanism through which normal meiotic recombination was affected by uv radiation is discussed. (auth)

10749 EFFECT OF SIGMA VIRUS ON DEVELOPMENTAL DELAY IN DROSOPHILA MELANOGASTER CAUSED BY X-RAY INDUCED MUTANTS IN HETEROZYGOUS CONDITION. Baumiller, Robert C. (Woodstock Coll., Md. Johns Hopkins School of Medicine, Baltimore). Mutat. Res., 4: 831-6(Nov.-Dec. 1967).

Four strains of Drosophila melanogaster were tested for their response to newly introduced heterozygous mutants both when infected with sigma virus and when cured. Two unstably virus infected strains show a significantly enhanced deleterious effect of such mutants when virus was present. Two stably virus infected strains showed a significantly enhanced effect when virus was absent. These reactions are apparently not correlated with the mode of infection, stable or unstable, of a given viral strain. It is hypothesized that genetic differences between the flies, their virus, or both are responsible for the differences observed; stably infected flies being less stressed by heterozygous mutants when infected than when cured, unstably infected flies being more stressed by heterozygous mutants when infected than when cured. (auth)

10750 ANALYSIS OF SPECIFIC-ACTIVITY CONCEPT AS RELATED TO ENVIRONMENTAL CONCENTRATION OF RADIONUCLIDES. Kaye, S. V.; Nelson, D. J. Nucl. Safety, 9: 53-8(Jan.-Feb. 1968).

The specific-activity technique is reviewed and evaluated for estimating potential hazards to man from consuming food or water derived from radioactivity-contaminated aquatic environments. Pertinent literature on past applications of this technique is discussed, and the findings are interpreted. A specific-activity model proposed by the National Academy of Sciences–National Research Council is evaluated with an analysis of the time-dependent parameters (biological half-time, physical half-life, and biological growth) to determine the sensitivity of the calculated maximum allowable specific activity of radioactivity in the aquatic environment to changes in the parameters. In all cases the guidance given by the specific-activity approach is conservative. The major restriction on application of the specific-activity models appears to be incomplete mixing and differing biological availability between the radioisotope and the stable-isotope analog. (auth)

10751 TYPES OF RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN CELLS. Visfeldt, Jakob (Kommunehospitalet, Copenhagen). Acta Pathol. Microbiol. Scand., Suppl. 187, 116(1967).

Three series of experiments are described. In the first one, three patients received an experimental dose of 100 R to a small field on the right forearm, and biopsies were taken from this and control areas. The biopsied cells were cultured for two to six weeks, and chromosome preparations made. About 1500 cells were analyzed. Several clones with definite structural chromosome aberrations were observed. Only chromosome aberrations of stable types were seen, and the karyotypes were balanced. In the second experiment, short-term cultures of peripheral blood from patients with cancer of the uterine cervix stage I were drawn immediately before, 1 hr after, 1, 2, 4, and 6 hr after radiation treatment. Chromosome analyses showed aberrations of both stable and unstable types. Immediately after termination of the exposure almost 40% of analyzed cells presented chromosome aberrations, and 15 yr after radiation treatment, damaged cells could still be found. In the third series, newly established cultures of peripheral blood from three healthy volunteers were γ-irradiated in vitro at does of 0, 50, 100, and 200 R. No qualitative differences were found between the patterns of aberration of the blood cultures from the irradiated patients and those blood cultures irradiated in vitro. (BBB)

10752 STUDY ON THE MUTAGENIC ACTION OF UV RADIATION ON CELLULAR ANTHRAX BACTERIOPHAGE. Valerianov, Tz.; Veljanov, D. (Inst. of Microbiology, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 723-6(1967).

The mutagenic effects of x radiation on anthrax phage were studied in exocellular phages. With doses exceeding 132 erg/mm^2 mutant colonies were detected that were 1 mm in diameter and devoid of a peripheral zone of incomplete lysis. The percent of uv-induced mutants in the surviving phage particles increased with dose, reaching a maximum at 660 erg/mm^2. An irradiated mixture of two phages showed equal sensitivity of both phages within the limits of the doses used. (H.L.W.)

10753 RADIOSENSITIVITY OF SIX HORTICULTURAL SPECIES. Cavazza, L. (Univ., Bari, Italy); Guerrieri, G.; Pacucci, G.; Scarascia Mugnozza, G. T. Genet. Agr., 19: 243-62(May 15, 1965). (In Italian).

The radiosensitivity of six horticultural species (cauliflower, lettuce, cucumber, pepper, pea, and tomato) was examined in terms of germinability, survival at seedling stage and mean dry weight per seedling. For each species five cultivars were investigated. Seeds were treated with x rays after conditioning at normal moisture. Significant survival differences among cultivars of all species except tomato were observed; moreover, in four species (cauliflower, lettuce, pepper, pea) the behavior of cultivars with regard to doses was found to be significantly different. Calculation of LD_{50} on survival data, by the estimation of probits regression, shows that in cauliflower, pepper, and lettuce the LD_{50} differs by a factor of two or more. On the contrary, relative uniformity was found in cucumber (51.8; 57.34 kR) and tomato (60.8; 68.2 kR). Since differences among cultivars of the same species seem clear cut and often very relevant, it is concluded that, in order to use correct doses in radiogenetics researches, it is first necessary to ascertain whether radiosensitivity differences exist among genotypes of the same species. This conclusion is strengthened by the fact that the LD_{50} values observed in this experiment frequently differed from those found by other authors. (auth)

10754 PHENOTYPIC EXPRESSION AND GENETIC LOCATION OF MUTATIONS IMPAIRING MALTOSE METABOLISM IN ESCHERICHIA COLI K12. Schwartz, Maxime (Institut Pasteur, Paris). Ann. Inst. Pasteur, 112: 673-700(June 1967). (In French).

Some mutants induced by uv radiation and by N-methyl-N-nitro-N-nitrosoguanidine are described. The uv-induced mutants were produced by irradiation of suspensions of bacteria (2×10^8/ml) in the exponential growth phase in medium M63 at uv doses giving between 0.1 and 1% surviving cells. In other cultures the chemical agent was added at a concentration of 400 μg/ml. A series of E. coli K12 mutants having impaired maltose metabolism was classified. Their content of permease, amylomaltase, and phosphorylase activity was determined, together with their sensitivity to phage λ. The corresponding mutations were mapped in either of the two loci malA or malB, and assignment of the amylomaltase and phosphorylase structural genes was made to the malA locus. Pleotropic mutations (called MT), resulting in a deficiency of amylomaltase, phosphorylase, and permease and in resistance to phage λ, also exist in malA. Mutations in the malB region could have at least three kinds of phenotypic expression: the same as the MT mutations of malA; deficiency of amylomaltase, phosphorylase, and permease not associated with resistance to phage λ; and impairment of the permease associated with a constitutive synthesis of amylomaltase and phosphorylase. Evidence is offered suggesting that the last two phenotypes may result from mutations in a single gene. This gene may be a structural gene of maltose permease. (BBB)

Health Physics and Safety

Refer also to abstracts 10321, 10374, 10368, 10609, 10613, 10614, 10665, 10702, 10740, 10807, 10821, 10839, and 10846.

10755 (BNWL-439(App.)) EVALUATION OF RADIOLOGICAL CONDITIONS IN THE VICINITY OF HANFORD FOR 1966. APPENDICES. Essig, T. H. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1967. Contract AT(45-1)-1830. 116p. Dep. CFSTI.

Results are tabulated from radiochemical analyses of environmental samples and from radiological measurements made in the Hanford environs during 1966. (C.H.)

10756 (COO-1540-5) POLONIUM RADIOISOTOPES IN TOBACCO AND THE ATMOSPHERE. Frost, J.; Sackett, W. M. (Tulsa Univ., Okla. Dept. of Chemistry). June 1, 1967. Contract AT(11-1)-1540. 17p.

Polonium-210, an alpha particle emitting radioisotope, is a natural contaminant in cigarette tobacco. Upon smoking a cigarette much of this ^{210}Po is transferred to the lung where it may cause types of bronchial cancer. People also ingest other polonium radioisotopes through breathing, that may render the ^{210}Po from cigarettes negligible. In this paper the relative contributions from these two sources is examined. (auth)

10757 (FOA-4-4491-24) SYNPUNKTER PA RISKER OCH ATGARDER VID INTERN OCH EXTERN KONTAMINERING PA GRUND AV RADIAKBELAGGNING. I. PERSONAL INOM CIVILFORSVARET OCH DET MILITARA FORSVARET UNDER KRIGSFORHALLANDEN. (Viewpoints on Dangers and Precautions of Internal and External Contamination on the Basis of Radioactive Fallout. I. Personnel with Civilian and the Military Forces Under War Conditions). Edvarson, K.; Greitz, U. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jan. 1967. 12p. (In Swedish). Dep.

With data from the literature on radiation studies and studies on the ecological conditions, criteria for control and restrictive precautions with fallout were reported. The discussions related to military and civil personnel under war conditions. (tr-auth)

10758 (ISS-66/32) STUDIO COMPARATO DELLA LEGISLAZIONE TEDESCA E ITALIANA SULLA MANIPOLAZIONE DELLE SOSTANZE RADIOATTIVE. (Comparative Studies of German and Italian Legislation on Handling Radioactive Substances). Francaviglia, S. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 21, 1966. 17p. (In Italian). Dep.

The German and Italian laws concerning the commercial handling of radioactive substances with special reference to nuclear plants (not for scientific use) are compared. It is found that the two laws are developed along different lines and the Italian laws appear to be incomplete. (auth)

10759 (JINR-P16-3587) IZMERENIE FAKTORA KACHESTVA NEITRONOV VYSOKIKH ENERGII V TKANEEKVIVALENTNOM FANTOME. (Measurement of the Quality for High-Energy Neutrons in the Tissue-Equivalent Phantom). Zel'chinskii, M.; Komochkov, M. M.; Sychev, B. S.; Cherevatenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 7p. (In Russian). Dep.

Distribution of the dose rate and the quality factor in the tissue-equivalent phantom, bombarded with the neutron beam with a maximum energy of 700 MeV, is investigated. The measurements were performed by using a recombination ionization chamber. By comparing the value of the dose rate at the depth of 2.5 cm and that of the neutron flux ($E < 20$ MeV) the ratio $(8.6 \pm 2.1)\ 10^{-9}$ rad/neutr. cm^{-2} is obtained. (auth)

10760 (MIT-952-4, pp 1-131) RADIUM AND MESOTHORIUM TOXICITY IN HUMAN BEINGS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Studies on radium and mesothorium cases are presented. These studies include complete in-vivo measurements, field breath radon sampling, whole-bone activities in exhumation cases, analysis of excreta, and microangiographic and microradiographic studies. A statistical analysis of the incidence of radiation-related malignancy in radium and mesothorium cases is presented. The radiobiology and physics of the lung cancer problem are surveyed in detail and the relation between the carcinomas of the paranasal sinuses seen in radium and mesothorium cases and the carcinogenesis of radon daughter products inhaled by uranium miners is discussed. (auth)

10761 (MIT-952-4, pp 132-201) DOSIMETRY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

A new semi-empirical relation for the rate of loss of energy with distance (LET) of heavy charged particles in matter has been found. The relation has been applied to the analysis of straggling experiments and to the derivation of range-energy relationships. The rate of energy loss of alpha particles in compact bone is discussed. A comprehensive analysis has been performed of the alpha dosimetry of the bone-tissue and air-tissue interfaces in the sinus cavities of the radium and mesothorium cases. (auth)

10762 (MIT-952-4, pp 202-19) GENERAL RADIOBIOLOGY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Data from the long-term ^{137}Cs body burden monitoring program were analyzed to determine the degree of similarity in relative change for the various subjects. Measurements of natural ^{40}K whole-body activity were applied to various nutrition and muscle disease studies. (auth)

10763 (PEL-160) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the Year 1966. van As, D.; Fourie, H. O.; Jordaan, Constance M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug. 1967. 51p. Dep.

Total alpha and beta activity was measured in soil samples and total beta activity in vegetation samples taken up to a distance of 1.5 miles from the reactor. Determinations for the individual nuclides ^{90}Sr, ^{137}Cs and ^{40}K were made. Monthly samples of water, sediment and waterplants were taken in the Crocodile River and analyzed for total alpha and total beta activity. The activities of the individual nuclides ^{90}Sr, ^{137}Cs and ^{40}K were determined in semi-annual bulked samples. Nuclear-bomb fallout was collected at weekly intervals in fall-out pots and counted for total beta activity as well as individual nuclides in quarterly bulked samples. Samples of water, sediment and plankton were taken semi-annually from the Hartbeespoort Dam and measured for total alpha and total beta activity. Fish samples were collected from the Crocodile River and the Hartbeespoort Dam. Total beta activity as well as ^{90}Sr, ^{137}Cs and ^{40}K were measured in fish. Milk was collected to a distance of 15 miles from the reactor at two-monthly intervals. Total beta activity as well as ^{90}Sr, ^{137}Cs and ^{40}K were measured. Soil, fodder and farm products, e.g., fruit, vegetables and lucerne, were also sampled and measured for total beta activity. Gamma surveys were done to a distance of 20 miles from the reactor. Daily air samples were collected by filtering $30m^3$ of air. (J.C.W.)

10764 (SFL-A-8) STUDIES ON ENVIRONMENTAL RADIOACTIVITY IN FINLAND, 1966. Annual Report. (Institute of Radiation Physics, Helsinki (Finland)). Oct. 1967. 58p. Dep.

Data are presented on the content of ^{137}Cs and ^{90}Sr in precipitation, surface waters, drinking water, and milk in Finland during 1966. Whole-body counting was used to measure the content of ^{137}Cs of man. Data are included on the Cs/K ratio of men and women. (C.H.)

10765 (LB/G-2598) SUITS MADE FROM PVC, FOR THE PROTECTION OF PERSONS AGAINST RADIOACTIVE CONTAMINATION. Suter, F. Translated by R. A. Scutt (Atomic Energy Research Establishment, Harwell, Eng.), from Atompraxis, 13: 180-5(1967). 17p. Dep. CFSTI. UK. JCL $1.60 fs, $0.80 mf.

Design specifications are presented for three types of chloroethylene vinyl, high-frequency-welded protective suits. A non-ventilated light-weight disposable suit was designed to be worn together with a gas mask in an environment lightly contaminated with dust; light-weight, ventilated, disposable suit with a transparent helmet was designed for use in a highly contaminated environment; and a heavy-weight ventilated suit, made of a special foil was designed to be used for repeated exposure in an atmosphere contaminated with tritium or radioactive gases. The three suits can be equipped with automatic, battery-powered, communication equipment. Physiological conditions in the ventilated protective suits under conditions of great bodily stress were tested in the laboratory, and it was concluded that the average CO_2 concentration remained reasonable as long as the prescribed air flow was ensured. The length of time that the heavy, ventilated suit can be used in an atmosphere contaminated with tritium in the form of water vapor was tested. Test results showed that the ratio of tritium content of air in the working space and in the suit was 1:1000. Maximum length of time during which a person wearing the suit could remain in a tritium atmosphere of a given specific activity before exceeding the maximum permissible intake of 250 μCi/week as recommended by the ICRP was calculated. (C.H.)

10766 IN VITRO EXPERIMENTS TO STUDY THE SOLUBILITY OF URANIUM AND RADIUM-CONTAINING AEROSOLS. Csovari, Mihaly; Toth, Arpad; Zsoldos, Tibor; Nagy, Lajos. Kiserl. Orvostud., 29: 225-30(June 1967). (In Hungarian).

Studies were conducted to determine the solubility of natural aerosols containing uranium and radium. It was attempted in the course of the experiments to reproduce a similar state to that found in the human organism. The solubility studies carried out at pH 1 (stomach) and pH 7 (lung) were aimed at the correlation of the results of routine urine analyses with the maximal allowable concentrations recommended in the literature which are given for water-soluble and water-insoluble compounds. The materials

tested were diuranate and uranium ore dust. The solubility conditions of uranium and radium were determined in vitro and recommendations were made concerning the maximal allowable concentration values in the urine. (JPRS)

10767 LEGAL ASPECTS OF A RADIATION-SAFETY PROGRAM. Smith, J. Lloyd Isotop. Radiat. Technol., 5: 54-8(Fall 1967).

Some of the legal benefits of making and keeping good radiation-exposure records are considered. Three lawsuits are referenced and discussed in which such records were valuable. There is some discussion concerning the information that should be recorded, the type records that are admissible in a court action, and how long radiation records should be kept. Some conclusions are drawn as to why the general public is so fearful and confused regarding all radiation, and attention is called to the need for continuing good records. (auth)

10768 RADIOACTIVE FOOD CHAINS IN SUBARCTIC REGIONS. Miettinen, Jorma K. (Univ. of Helsinki). Bibl. Nutr. Dieta, 9: 43-58(1957).

Levels of ^{90}Sr and particularly ^{137}Cs in plants, animals, and humans of Northern Finland (Lapland) are reported. Some analyses made in 1963 of wild plants important as fodder for reindeer and cattle are presented. The radioactivity of lichen was, even in this year of maximum fallout, up to 10 times higher than that of the other plants; in the previous years the ratio was even greater. The lichen retains for many years the radioactivity it has taken up. The ability of lichen to absorb and store fallout nuclides is due to its structure and its extremely slow growth. A comparison of radioactivity between wild and cultivated grass showed the former being two to four times more active. Also grass growing on flooded shores of rivers and lakes was more active than grass growing in dry soil, due to the deficiency in mineral nutrients of the extremely pure water of many Lapland lakes. The difference was even more conspicuous in fish. The ^{137}Cs content of fish was up to 100 times higher than in the nutrient-rich lakes common in other parts of Finland and Europe. There are three efficient food chains of ^{137}Cs prevailing in Lapland, one leading from lichen to reindeer meat, another from sedges and horsetails to bovine meat and milk, and the third from the pure fresh waters through plankton to the fish. Thus important constituents of the human diet in Lapland contain 10 to 60 times more ^{137}Cs than in southern Finland. The ^{137}Cs content of different foods in 1962 is tabulated. Measurements made in the spring of 1961 on adult male Lapps by a whole-body counter showed a level of 1.0 μCi ^{137}Cs that corresponds to an annual whole-body radiation dose of about 0.1 rem, with due allowance to the smaller body burden in summer. This is one-fifth of the maximum permissible level set by the International Commission for Radiation Protection for any individual of the general public. (BBB)

10769 THE ANALYTICAL DETERMINATION OF ^{90}Sr IN FOODS. Davis, Sidney (Dept. of Health, Education, and Welfare, Washington, D. C.). Residue Rev., 12: 1-13(1966).

The chemistry of Sr and Y applicable to ^{90}Sr determinations is reviewed in addition to gravimetric methods of separation, ion-exchange and other chromatographic methods, and solvent extraction methods for ^{90}Sr assay of foods. Solvent extraction procedures have become most popular for the separation of radionuclides. Of the many organic chelating agents, thenoyl trifluoracetone, tributyl phosphate, and di-(2-ethyl hexyl) phosphoric acid are most generally used for the separation of ^{90}Y. Strontium-90 determinations by liquid-liquid partition techniques appear to be most promising from the standpoint of rapidity of analysis with accuracy comparative with the classical gravimetric methods. The chromatographic ion-exchange and solvent-extraction methods, as attempts to simplify the classical gravimetric separation steps of the earlier ^{90}Sr methods, are a step in the trend toward simplification. As the environmental contamination of food supply by fallout diminishes due to the cessation of atmospheric testing, more simplified techniques of analyses will be required. However, the problem of handling still larger amounts of food samples in order to attain sufficient activity for good counting statistics will result in the tendency to complicate the early stages of analysis of ^{90}Sr in foods. The determination of ^{90}Y is used to circumvent the difficulties involved in the presence of significant amounts of ^{89}Sr with ^{90}Sr for periods up to 300 days after detonation of a nuclear device. (BBB)

10770 MEASUREMENT OF RESIDUAL RADIOACTIVITY IN NAGASAKI. Okazima, Shunzo; Ookawara, Shigeyuki; Abe, Takeo (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 40: 668-70(Aug. 1965). (In Japanese).

The existence of residual radioactivity, e.g., ^{89}Sr, ^{90}Y, ^{140}Ba, and ^{137}Cs, in the western area of the city of Nagasaki was reported. Most radioactivity from the atomic bomb should have disappeared during the 19-yr period. An examination of residual radioactivity was reported for: Surface water: 20 l samples were condensed, dried, and dissolved in 6N HCl and the radioactivity was measured with low-background 2π gas flow counter. The results showed 6.38 ± 2.8 to 21.59 ± 3.1 $\mu\mu$Ci/l, which was not significantly different from the control levels. Soil: 700 g of soil from each of 6 sites was dried and the radioactivity in 20-g samples was measured by standard methods of radioactivity assay. The range of radioactivity was 3.5 to 29.7 $\mu\mu$Ci/g, not significantly different from control samples. Human bone: the radioactivity of bone from 11 autopsy cases of atomic bomb survivors was measured. The bones were assayed separately (femora, vertebrae, and bones of the hand). Muscle and fat were removed completely from the tissue and the dried bones were ashed at 450 to 550°C. The radioactivity was measured by methods similar to those used in the previous assays. The results showed 0.4 to 6.1 $\mu\mu$Ci/g. The radioactivity of vertebrae was generally higher than in the other bones; however, it was not significantly different from that in controls. During the 19-year period, it was evident that almost all of the radioactivity from the bomb explosion in water and soil decreased through physical decay of the radionuclides and due to the effects of weather. (BBB)

10771 DEPOSITION OF PARTICLES TO NATURAL SURFACES. Chamberlain, A. C. (Atomic Energy Research Establishment, Harwell, Eng.). Symp. Soc. Gen. Microbiol., No. 17, 138-64(1967).

The deposition of particles in the size range 1 to 50μ is considered under the following headings: introduction; sedimentation velocity and related concepts (factors modifying rate of sedimentation: density, shape, interaction between particles and air in a cloud); impaction; deposition to grassland and other extended surfaces; washout of particles by rain (impaction on raindrops, rates of washout); and deposition indoors (re-suspension of dust). (UKAE)

10772 UPTAKE COEFFICIENTS FOR CALCIUM, STRONTIUM, AND ^{90}Sr IN SOME MARINE ORGANISMS. Bachurin, A. A.; Kulebakina, L. G.; Polikarpov, G. G. Radiobiologiya, 7: 481-3(1967). (In Russian).

The uptake coefficients for Ca, Sr, and ^{90}Sr, the ratios of K_{Sr}/K^{m}_{Sr}, the discrimination factors D(Sr/Ca), and the Sr/Ca ratios were determined for 17 species of marine organisms (four of algae, three of mollusca, two of crustacea, and eight of fish) collected during 1964 and 1965 on the land shelf in the vicinity of Sevastopol' and in the Kara-Dag region. The ratio K_{Sr}/K^{m}_{Sr} in the organisms studied was 1.0 ± 0.3, i.e., ^{90}Sr was in equilibrium with ^{89}Sr in these organisms as far as isotope exchange between them and sea water was concerned. (JPRS)

10773 THE CONCENTRATION OF ^{137}Cs AND ^{90}Sr IN THE FLESH OF BROWN TROUT TAKEN FROM RIVERS AND LAKES IN THE BRITISH ISLES BETWEEN 1961 AND 1966: THE VARIBLES DETERMINING THE CONCENTRATIONS AND THEIR USE IN RADIOLOGICAL ASSESSMENTS. Preston, A.; Jefferies, D. F.; Dutton, J. W. R. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Water Res., 1: 475-96(July 1967).

The concentrations are reported from two complementary studies: a detailed study over a six-year period of Lake Trawsfynydd, comparing quantities of deposited radioactive fallout and water and flesh concentrations for both radionuclides, and general surveys of waters throughout the British Isles. From the British Isles surveys caesium-137 concentrations are related to potassium concentrations in the water and strontium-90 concentrations to calcium concentrations in the water, both as specific activities and as concentration factors, for the whole range of conditions from very dilute calcium bicarbonate surface waters to the marine conditions of coastal waters. It is demonstrated that concentrations of caesium-137 in brown trout flesh from some Scottish waters were probably as high as any recorded from arctic ecosystems. Concentrations of both contaminants in the trout flesh can be expressed as functions of water conductivity in calcium bicarbonate surface waters from Britain, and it is suggested that this may be a useful general approach to radiological assessments involving fish from many such surface waters. The radiological implications of the principal conclusions are discussed and simple "risk diagrams" are produced as a guide to the assessment of different situations. It is shown that strontium-90, at or below I.C.R.P. public drinking water concentrations, is unlikely to be a hazard as a result of the human consumption of trout from any area in the British Isles, but that caesium-137 is a potential hazard in some areas down to consumption rates as low as 0.4 g of flesh per day. The results of previous work with these two radionuclides in fresh-water ecosystems are briefly discussed in the context of the studies reported. (auth) (UK)

10774 CALIBRATION OF THE FERROUS SULFATE DOSIMETER BY IONOMETRIC AND CALORIMETRIC METHODS FOR RADIATIONS OF A WIDE RANGE OF ENERGY. Fregene, A. O. (Cambridge Univ., Eng.). Radiat. Res., 31: 256-72 (June 1967).

A detailed investigation of the ferrous sulfate radiation dosimeter was carried out, and $G^{++}_{Fe} \rightarrow {}_{Fe}{}^{+++}$ values were determined for a number of γ-, X-, and β-rays of a wide range of radiation energy with an overall accuracy of some $\pm 2\%$. Ionization methods of estimation of absorbed radiation dose were employed for 14-MeV X-rays, ^{60}Co γ-rays, ^{137}Cs γ-rays, ^{192}Ir γ-rays, 220-kVp X-rays, 100-kVp X-rays, 60-kVp X-rays, and ^{90}Y β-rays; and particle counting was used for estimating the radiation energy emitted by ^{3}H, ^{35}S, and ^{32}P β-rays. An isothermal microcalorimetric method was also used in the calibration of the ^{3}H and ^{32}P radioactive samples, and an adiabatic one for the absorbed dose measurement of the 14-MeV X-rays, the ^{60}Co γ-rays, and the 220-kVp X-rays. The results obtained are in general agreement with most recently published values of other workers for corresponding radiation qualities where these were investigated. (auth)

10775 LIFE TABLES. 40th CONTINUATION. VI. RADIATION AND ATOMIC FISSION. PART 6. RADIOACTIVE CONTAMINATION OF FOODSTUFFS, AIR, AND WATER THROUGH NUCLEAR WEAPON TESTS. Herbst, Willy (Univ., Freibrg i.B.). Vitalst.- Zvilisationskr., 9: 155-7(Aug. 1964). (In German).

Tabulated data are presented for content of ^{90}Sr, ^{89}Sr, ^{137}Cs, and ^{131}I in milk from 1959 to 1963 in the U.S.A.; ^{14}C content of the atmosphere, trophosphere, and stratosphere in the northern and southern hemispheres for various altitudes up to 30 Km, and in oceanic waters; ^{90}Sr, ^{137}Cs, and ^{144}Ce in wheat and wheat products during 1962 in the U.S.A.; average estimated radiation burden on the human population in the U.S.A. up to 1962 resulting from nuclear weapon tests; estimated incidence of birth malformations, leukemia, and bone tumors in the U.S.A. up to 1961 resulting from nuclear weapon tests; residual ^{90}Sr, ^{131}I, and ^{137}Cs content of whole milk; ^{90}Sr deposition in the northern and southern hemispheres from 1958 to 1963 in MCi; and content of ^{90}Sr and ^{137}Cs in vegetables, fruit, and potatoes in 1963 in Germany. (BBB)

10776 NATURAL RADIOACTIVITY AND ^{137}Cs IN ALASKAN CARIBOU AND REINDEER SAMPLES. Blanchard, Richard L.; Kearney, Jasper W. (Dept. of Health, Education, and Welfare, Cincinnati). Environ. Sci. Technol., 1: 932-9(Nov. 1967).

The concentrations of ^{210}Po, ^{210}Pb, ^{226}Ra, and ^{137}Cs were determined in bone, muscle, and rumen content of caribou and reindeer from Alaska. The ^{210}Po and ^{137}Cs concentrations in the muscle varied with the season, reaching a maximum in spring and a minimum in the fall. A similar variation in the ^{210}Po and ^{137}Cs concentrations was observed in the rumen content. The relations of ^{210}Po and ^{137}Cs between muscle and rumen content are examined. The ^{210}Po to ^{210}Pb ratio in muscle also varied during the year reaching a maximum in the spring. The ^{210}Pb content of the bone did not appear to vary with the season; however, an increase occurred with increasing latitude and age. Except for animals one year or less in age, the ^{210}Po to ^{210}Pb activity ratio was near unity. The specific activities of ^{226}Ra in bone and muscle were small in comparison with the concentrations of ^{210}Pb, ^{210}Po, and ^{137}Cs. (auth)

10777 A SIMPLE METHOD FOR THE SCATTERED DOSE DETERMINATION OF SOFT X RADIATION (50 TO 100 keV). Blattmann, H. (Univ., Zurich). Radiol. Clin. Biol., 35: 292-9(1966). (In German).

A method was given to determine with simple means a very low dose of scattered radiation. The method was demonstrated by the example of a local irradiation with 100 KV x rays of a tumor in mice. The shielding possibilities in partial irradiation of small objects were investigated. (tr-auth)

10778 PRINCIPLES OF RADIATION PROTECTION. Morgan, K. Z.; Turner, J. E. (eds.). A Textbook of Health Physics. New York, John Wiley and Sons, Inc., Publishers, 1967. 638p. $13.95.

Sixteen chapters are presented on the following topics: the history of damage and protection from man-made and natural sources of ionizing radiation; the mechanisms and effects of the passage of heavy charged particles, γ rays, and x rays through matter; quantities and units of radiation dose; the physical basis of radiation dosimetry; detection and measurement of ionization, ionization methods of mixed radiation dosimetry, and special methods in dosimetry; theory of electron and β-ray spectroscopy; calculation of and standards for external and internal doses of radiation; biophysics of direct and indirect effects of radiation on biological materials; radiation biology at the molecular, cellular, and organismic levels; evaluation of human exposure data; characteristics, calibration, and maintenance of radiation detectors and component instrumentation used in health physics; and theory and criteria useful in the prevention of criticality accidents. Reference citations and problems are presented at the end of each chapter, and author and subject indexes are included at the end of the text. (E.R.B.)

10779 SPRAVOCHNIK PO RADIATSIONNOI BEZOPASNOSTI. (Handbook on Radiation Protection). Kozlov, V. F.; Troshkin, Yu. S. Moscow, Atomizdat, 1967. 276p.

Questions of radiation protection provisions and the organization of dosimetric controls in installations using radioactive materials and sources of ionizing radiation were briefly considered. Basic data on the interaction of ionizing radiation with matter were reported; the biological effects of radiation, the level of natural irradiation of the human organism, permissible radiation dose, dose calculation, radiation protection, and ionization, scintillation, photographic, chemical, and other methods for the determination of ionizing radiation were considered. Devices for the general and individual dosimetric control of x ray, γ, β, and neutron radiations were described. The radiometry of the internal contamination of the human organism and radiometry of gases and aerosols were discussed. Methods for the calibration of radiation devices were reported. Data were given on the preparation of radiation sources, transportation of radioactive materials, and elimination of radioactive wastes. (tr-auth)

10780 LUCHEVYE NAGRUZKI I PROTIBOLUCHEVAYA ZASHCHITA PRI RENTGENO-DIAZNOSTICHESKIKH PROTSEDURAKH. (Radiation Loads and Radiation Protection During X-ray Diagnostic Procedures). Katsman, A. Ya. Leningrad, Izdatel'stvo Meditsina Leningradskoe Otdelenie, 1966. 238p.

Contemporary concepts on the effects of low doses of radiation, used in x-ray diagnosis, on the patients and personnel and the protection methods are reported. The damaging effects of x radiation on humans and the early and delayed consequences are considered. (tr-auth)

Medicine

Refer also to abstracts 10545, 10574, 10735, 10738, 10780, 10831, 10833, 10837, 10842, 10844, 10850–10852, 10859, 10882, and 10888.

10781 (NYO-910-59) METABOLIC STUDIES IN CANCER WITH RADIOACTIVE ISOTOPES. Progress Report, May 1, 1966–May 1, 1967. Laughlin, John S.; Myers, W. P. Laird (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 15, 1967. Contract AT(30-1)-910. 25p. Dep. CFSTI.

COMPUTER PROGRAMS — performance in analysis of scanning data
GAMMA CAMERAS — design and performance of
COLLIMATORS — gamma path in multihole focusing, derivation of expressions for length of
CALCIUM-47 — uptake by bones of man, for use in detecting occult metastases
STRONTIUM-87 — uptake by bones of man, for use in detecting occult metastases
FLUORINE-18 — scanning in bones of man,
STRONTIUM-85 — scanning in bones of man
GALLIUM-68 — scanning in bones of man
DISEASES, NEOPLASTIC — metastases, radiodiagnosis of occult bone in man, clinical evaluation of isotopes for (B.H.S.)

10782 (UCLA-34P119-10) CLINICAL APPLICATIONS OF A HIGH QUANTUM UTILIZATION SCANNER. Annual Progress Report, July 1966–1967. (California Univ., Los Angeles. School of Medicine). Apr. 15, 1967. Contract AT(11-1)-34. 17p. Dep. CFSTI.

Progress is reported on the development of radioisotope scanning techniques for the detection of brain lesions that alter the blood-brain barrier phenomenon. Preliminary results are reported from clinical tests using a high quantum fast section scanner consisting of a 2,250-hole collimator and 65-lb of irregular pieces of crystal about 2 in. thick with a hydraulic drive system and dot printout system for the localization of γ radiation from ^{51}Cr-labeled tetracycline concentrated in brain neoplasms or alterations in distribution indicating the presence of aneurysms or cerebral ischemic or thrombotic lesions. Excellent results were obtained in a limited number of cases. The findings were compared with those obtained using a photoscanner or a scintillation camera. Data are also included from studies on the toxicity and tissue distribution of ^{51}Cr-labeled tetracycline in mice. Procedures for the preparation of ^{51}Cr-labeled tetracy-

cline are included. A search for other compounds for use as tracers for scanning brain lesions led to the preparation of ^{125}I- and ^{131}I-labeled insulin, dextran, and mannitol and stable chelates of acetylacetone labeled with ^{51}Cr or ^{59}Fe. Procedures for the preparation of these compounds are included. (C.H.)

10783 EFFECT OF DEOXYRIBONUCLEIC ACID ON SURVIVAL TIME AND ON HISTOCHEMICAL AND MORPHOLOGIC CHANGES IN THE LIVER OF RATS AFTER IRRADIATION. Bankowski, Z.; Polowiec, Z.; Steplewski, Z.; Wilczok, T. (Research Center of Experimental Pathology, Warsaw). Ann. Histochim., 12: 113-24 (Apr.-May-June 1967). (In French).

In attempts to demonstrate a radioprotective effect of exogenous DNA on the liver, male and female Wistar rats, aged 3.5 and 7 months, were whole-body irradiated by a single dose of 900 R of γ rays from ^{60}Co. Calf thymus DNA in highly polymerized form was injected intraperitoneally in doses of 3 mg 24, 48, and 72 hr after irradiation. All irradiated animals, not treated with DNA died between the 5th and 18th day. The survival time of treated animals varied, according to different groups, between 58 and 71%. By histochemical means, alkaline and acid phosphatases, DNA II, ATP, and lipids were demonstrated. Various morphologic changes also were investigated histologically in the liver. The histochemical and morphological patterns of DNA-treated rat liver up to the 12th day after irradiation were similar to those of liver, but irradiated liver of untreated rats showed extensive necrosis and lipid degeneration. The results indicated an increase of the regenerating ability in the liver due to administered DNA. (BBB)

10784 THE INTRANUCLEAR TRACER, CELL VIABILITY, AND PRE-OPERATIVE IRRADIATION. Goldman, Joseph L.; Friedman, William H. (Mount Sinai Hospital, New York). Laryngoscope, 77: 1315-27 (Aug. 1967).

Labeling of irradiated squamous cell cancern of the larynx with tritium labeled thymidine was studied by use of biopsy specimens removed at the time of surgery. A biopsy section of nonirradiated squamous cell carcinoma of the larynx showed complete disorganization of squamous elements, the presence of keratin, intercellular bridges, and bizarre, large ovoid nuclei with great numbers of mitotic figures, indicating typical, well-differentiated epidermoid cancer. Heavily labeled cells were present as seen by grains of reduced silver in the photographic emulsion coating each section. Both histologically and radiobiologically this appeared to be a thriving tumor with a large proportion of cells actively synthesizing DNA, thus in the S phase of the cell cycle. The same tumor examined immediately after a cumulative 2700-rad dose of ^{60}Co teletherapy revealed a much different histologic picture. There was less uniformity of cell type, and histologic evidence of cell death was present as pyknotic nuclei, vacuolated cytoplasm, and cellular debris. Some labeled nuclei were seen, an occasional high-power field revealing as many as three labeled cells. At 1000 times magnification the intensity of ^{3}H labeling in cells was less than that seen prior to irradiation, with no cell exposing more than 10 to 12 silver grains above the nucleus. The absence of tissue reaction, giant cells, or other evidence of a histological response to irradiation in the area of heaviest labeling was noted, but interpretation of this phenomenon was not possible. Cell viability was demonstrated unequivocally at doses as high as 5500 rad of ^{60}Co teletherapy, correlating with the finding that advanced cancers of the larynx may not respond to dosages of radiotherapy much greater than 5500 rad. (BBB)

10785 FUNDAMENTALS OF SOFT TISSUE RADIOGRAPHY (MAMMOGRAPHY). Scott, W. P. (Charlotte Memorial Hospital, N. C.); Willemin, Andre; Betsch, Claude. Radiol. Clin. N. Amer., 5: 169-80 (Apr. 1967).

Fundamental aspects of absorption and scattering of x rays in soft tissues are examined and applied to detection of breast cancer. Role of the Compton effect and attenuation of the incident beam are explained. In the range of photon energies used in radiodiagnosis (<150 keV), the probability of a Compton interaction with orbital electrons of atoms of soft tissue is practically the same for all electrons, irrespective of their orbit. The attenuation of a beam of photons as a result of the Compton effect is less in fat than in another soft tissue, regardless of the energy of the incident photon. It is theoretically possible to reduce the amount of scattered radiation in the direction of the primary beam by reducing the voltage. However, for primary photons with energies from 30 to 150 keV, there is little difference in the spatial distribution of scattered photons. For atoms of hydrogen, carbon, nitrogen and oxygen, the highest binding energy is found in the K electrons of oxygen (~300 eV), considerably less than the primary photon energy. Consequently, the only interaction of the photoelectric type even probable involves an interaction of a primary photon with a K electron. In soft tissue the total energy of the primary photon in photoelectric interactions is dissipated mainly as kinetic energy of the K photoelectron. Because the electron density of fat is lower than that of other soft tissues, attenuation of the beam by the photoelectric effect in a given thickness of fat is always less than that from either the photoelectric effect or the Compton effect in the same thickness of another soft tissue. Three situations are considered: The Compton effect predominates (primary photons of energy levels above 28 keV). The radiant image contains a relatively large scattered Compton component; neither Compton effect nor photoelectric effect predominates (photons of energy levels between 20 and 28 keV). The Compton effect is dominant in fat whereas the photoelectric effect is dominant in the other soft tissues; the photoelectric effect predominates (photons of energy levels below 20 keV). There is essentially no scattered radiation. There results a very pure radiant image. Conversion of the radiant image into a photographic image is explained, and it is shown how adherence to these physical principles of x-ray interaction in the tissues can result in detailed soft tissue radiographs, rich in contrasts. (BBB)

10786 STOMACH SCANNING AFTER INTRAVENOUS ^{99m}Tc ADMINISTRATION: A PRELIMINARY REPORT. Hofmeyr, N. G. (Univ. of Stellenbosch, S. Afr.). S. Afr. Med. J., 41: 572-5 (June 24, 1967).

The first use of ^{99m}Tc-pertechnetate for gastric scanning is reported. While investigating the use of pertechnetate in heart blood pool scanning, it was observed that stomach scans of good quality could be produced. Intravenous ^{99m}Tc-pertechnetate was concentrated by the gastric mucosa and secreted in the gastric juice, probably in the mucus. The patients were fasted for 12 hr before the investigation, and gastric aspiration via stomach tube was performed immediately before and during the scan in some cases. Two to 4 mCi of the ^{99m}Tc-pertechnetate (2 to 4 mCi) was given intravenously; 15 min later scanning was begun. Background counts were taken over the liver or heart; maximum counts were sought over the stomach and usually found in the mid-region or slightly higher, towards the fundus. Notwithstanding respiratory movements, gastric scans of good quality and definition were possible, even in the presence of achlorhydria, pyloric obstruction, and gastric perforation. Lesions causing destruction of the mucosa, especially carcinoma, were well shown, and could possibly be diagnosed before becoming obvious on barium meal examination. Gastric ulceration was not demonstrable in the absence of perforation, possibly because the ulcers became filled with radioactive gastric juice, or because of insufficient disturbance in the surrounding mucosa. (BBB)

10787 SKIN CANCER AND BREAST CANCER IN ATOMIC BOMB SURVIVORS. Tezuka, Hiroshi; Shigemachu, Sasuku; Sirabe, Laisuke (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 40: 593-5 (Aug. 1965). (In Japanese).

Several skin cancer and breast cancer patients among the atomic bomb survivors were studied. Breast cancer occurred in a 65-yr-old woman who was exposed to the atomic bombing at 44 years of age at a distance of 1.9 Km from the hypocenter. Her back and right arm suffered 2nd and 3rd degree burns. Nodules or other evidence of malignancy in the breasts were not observed at that time. Beginning in July, 1963 she experienced pain in the right breast, and in October, 1963 a tumor of 1 cm dia was noted in the right breast and it gradually increased in size. Blood examination showed a red cell count of 3,420,000 per mm^3, hemoglobin 8.9 g/dl, hematocrit 28%, and leukocytes 4400 per mm^3. Liver function was normal. The tumor was diagnosed as an invasive lactiferous duct carcinoma. Surgery and ^{60}Co irradiation therapy were employed. In the skin cancer case, the 60-yr-old subject had been exposed to atomic bombing at a distance of 2.5 Km from the hypocenter. The face, neck, and chest suffered 2nd to 3rd degree burns. The acute radiation symptoms included fever, hemorrhage, and alopecia at 3 months after exposure; then these symptoms gradually disappeared. Almost no symptoms were observed from 1955 to 1962. However, in August, 1962, some areas of skin were swollen and thickened, and several purulent 4 to 6 cm ulcers were present. The ulcers when removed surgically and examined histologically revealed a squamous cell carcinoma. (BBB)

10788 REPORT ON THE WORK OF THE ABCC. Nagai, Isamu (Atomic Bomb Casualty Commission, Nagasaki). Nagasaki Igakkai Zasshi, 40: 699-701 (Aug. 1965). (In Japanese).

The principal research projects of the ABCC on the mortality, disease incidence, and other pathologic findings in the atomic bomb survivors were reported. A survey of the mortality of atomic bomb survivors included the investigation of general longevity, life span of 26,000 children, and fetal mortality in irradiated mothers. A survey on disease incidence rates included general health investigations on 100,000 adult atomic bomb survivors and controls. Detailed health examinations were carried out on the subjects every 2 years and the effects of radiation on the incidence and type of

diseases seen were assessed. A survey of malignant tumors in survivors was conducted in both Hiroshima and Nagasaki. From July, 1962 to June, 1963, there were 1343 cases of malignant tumors in Hiroshima and 1243 cases in Nagasaki. For leukemia during 1962 and 1963 there were 706 cases in Hiroshima and 411 in Nagasaki. The special research subjects described included the effects of radiation on the incidence of cerebrocirculatory disease, thyroid function, liver diseases, and diabetes; sex ratio of the progeny from atomic bomb survivors and studies on chromosomes; and enzyme activity assays of leukocytes in adult atomic bomb survivors and fetuses of exposed mothers. Among 99,393 atomic bomb survivors studied from October, 1950 to September, 1960, there were 8614 deaths. The atomic bomb-exposed subjects at a distance of 0 to 1399 m from the explosion showed a higher mortality and higher incidence of tuberculosis, leukemia, and other malignant tumors than nonexposed subjects or the survivors who were at greater distances from the explosion. (BBB)

10789 EFFECTS OF HYPOTHERMIA DURING X-IRRADIATION ON THE DEVELOPMENT OF RADIATION INJURED CHICKEN EMBRYO. Partskhaladze, N. N. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 47: 189-92 (July 1967). (In Russian).

The influence of hypothermia on the development of radiation injuries in chicken embryos exposed to x radiation was studied using Russian White chicken eggs exposed to a single dose of 800 R. The tabulated data show that hypothermia does not increase survival of the exposed embryos; however, some of the pathological changes were delayed. (R.V.J.)

10790 PROTECTIVE EFFECTS OF RHODIZONIC ACID AND SOME OF ITS DERIVATIVES ON THE RADIOSENSITIVITY OF YEASTS IN CULTURE. Bru, A.; Seris, J. L.; Regis, H.; Soubiran, J.; Lucot, H. J. Radiol., Electrol., Med. Nucl., 48: 555-7(Oct. 1967). (In French).

The importance of polyphenols and quinones in oxido-reduction phenomena stimulated interest in the possible radioprotective effects of some of the intermediates formed in the course of the oxidation of meso-inositol, specifically the substance, rhodizonic acid. The radioprotective efficiency of the products was assessed by multiplication of x-irradiated yeast cells. Of the substances studied, clear-cut effects were obtained only with the hexahydroxybenzene-tetrahydroxyquinone, rhodizonic acid-tetrahydroxyquinone systems. (E.R.B.)

10791 TESTING OF ANTIRADIATION PROPERTIES OF PROPOLIS. Gorodetskii, O. P.; Kulyabko, P. M. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 805-8(1967). (In Russian).

Data indicate the ability of propolis to exert protective and therapeutic action on radiation injury. The survival of experimental mice reached 25 and 20%, respectively. At combined medico-preventive application propolis proved to be most effective. In this case, the survival of irradiated animals under experiment amounted to 37%. (auth)

10792 SUPPLEMENTARY HORMONAL TREATMENT OF CERVIX CARCINOMA. Hoff, Franz (Sanatorium fuer Frauenkrankheiten, Graz). Gebrutsh. Frauenheilk., 26: 810-13(May 1966). (In German).

In physiological doses, ovarian hormones administered to patients with cervical carcinoma are not cancerogenic. When administered weekly before and after irradiation, no effect was observed on tumor growth nor were any cytostatic effects observed. However, hormone administration appeared to prevent radioinduced atrophy and fibrosis. After treatment with 200 mg of follicular hormone and 500 mg of lutenizing hormone, chronic cystitis that was induced by irradiation treatment was healed. Among 255 patients, late reactions in the urinary bladder appeared in two patients after they were overdosed with 9000 to 10,000 mg-hr of Ra because of radioresistant cervical carcinoma. Although the other patients received Ra treatment in addition to intravaginal irradiation with 1200 R to each parametrium, there was no parametrial fibrosis or ureteral stenosis observed when supplemental hormone treatment was given. (BBB)

10793 RADIOTHERAPY OF BREAST CARCINOMA. Held, F. (Univ., Rostock, Ger.). Z. Aerztl. Fortbild., 59: 542-4 (May 15, 1965). (In German).

Presurgical irradiation for treatment of mammary carcinoma may produce a series of complications. If surgery is undertaken during a period when the tissues are hyperemic from the irradiation, the operation is made difficult. This is definitely so if the surgery is performed during the third to fifth week after beginning an intensive preirradiation. Preirradiation may alter the area where surgery is to be performed so much that it becomes extremely difficult to ascertain the differences between the malignant tissues and the healthy area surrounding them. The massive area preirradiated does not have the regenerative ability necessary to prevent infections, and so secondary healing with formation of prominent scars may result. Preirradiation may also reduce the frequently already impaired general condition of the patient even more. Irradiation even with high doses may leave some of the tumor tissue unaffected, as was noted with adenocarcinomas. Even relatively small doses of irradiation inducing inflammation such as is used for treatment of nasal or lip furuncles produce noticeable effects. Focal doses of 1000 R produce definite cellular radiation injuries. The presurgical irradiation should reach an average of 1000 to 1500 R. The use of ^{60}Co irradiation or betatron irradiation probably is more effective than conventional x irradiation. (BBB)

10794 RADIATION THERAPY WITH THE 15-MeV BETATRON FOR CERVIX CANCER. Watanabe, Hidekazu; Takayama, Kazuo; Taki, Sadamori; Fujiyoshi, Teruo (Kyushu Univ., Fukuoka). Gan No Rinsho, 10: 750-6(Oct. 1964). (In Japanese).

Effects of β radiation after therapy with the 15-MeV betatron in 36 cases of cervix cancer are reported. The irradiation dose rate was 34 R/min at a 70 cm distance, for single doses 200 to 400 R/day for five to fifteen sessions. The total irradiation dose amounted to 8000 to 18,000 R. The maximum irradiation dose was received between the surface of skin and 3.5 cm beneath the surface. The zone 10 cm below the surface received 76% of the maximum dose. Few injuries or side-reactions of irradiation were observed with this type of radiation therapy. In the patients irradiated with total doses of 14,000 R, normal liver function, without proteinuria or glucosuria, was observed. However, the hematocrit, hemoglobin concentration, and leukocyte counts fell slightly. The RBE of 15-MeV betatron irradiation in HeLa cells was also studied. HeLa cells were incubated in lactalbumin, Hanks balanced salt solution, and cow serum at 37°C and irradiated at a dose rate of 26.8 to 22.0 R/min. The radiation effect was compared with that of ^{60}Co γ rays (25.2 to 24.8 R/min) and 200-KV x rays (27.8 to 23.2 R/min). The cell counts after 200-KV x irradiation were lower and there were more unaltered cells after 15-MeV and ^{60}Co irradiation. The RBE values were 1.0 for 200-KV x rays, 0.72 for ^{60}Co γ rays, and 0.76 for 15 MeV β particles. These experimental results suggest that betatron irradiation provides very effective radiation therapy for cervical cancer. (BBB)

10795 THE FACTORS OF AN ATOMIC WEAPON DETONATION THAT EFFECT THE HUMAN ORGANISM AND THE MEASURES OF MEDICAL ASSISTANCE. Koenig, W. (Deutsche Akademie fuer Aerztliche Fortbildung, Berlin-Kaulsdorf, Ger.). Pharm. Praxis Beil., Pharm., No. 4, 92-5(1967). (In German).

The physical bases of injury from atomic weapon detonations, the factors such as the shock wave, heat radiation, ionizing radiation that cause their effects, multiple injuries, and possibilities for protection from physical damage and irradiation are reviewed. These factors are tabulated in terms of radiation type, immediate and delayed radiation, fission product formation and particle size, effects of whole-body irradiation, irradiation of specific organs, internal contamination with radioactive fallout, relative radiosensitivities of various organs, effects of combined injuries from irradiation and mechanical or thermal trauma, and various general procedures for treatment and care of atomic weapon casualties. (BBB)

10796 HEMOPOIETIC SPLEEN COLONY STUDIES. IV. PHYTOHEMAGGLUTININ AND HEMOPOIETIC REGENERATION. Curry, J. L.; Trentin, J. J. (Baylor Univ., Houston, Tex.). J. Exp. Med., 126: 819-31(Nov. 1, 1967).

The effects of phytohemagglutin (PHA) were studied in whole-body x irradiated (850 R) mice to see if a definite myeloproliferative effect could be demonstrated in vivo. Treatment of only the bone marrow donor with PHA caused a consistent but slight reduction in transplantable spleen colony-forming unit (CFU) content of the bone marrow 24 hr after the last PHA injection, but no change was found in the proportion of the various colony types. Treatment of the irradiated recipient of normal bone marrow with PHA caused no change in the number of spleen colonies. However, eight-day colonies were only about half normal size and much more likely to be of mixed cell types; they contained many large undifferentiated blastoid cells but fewer transplantable CFU. The spleen sinusoids were packed with hemopoietic cells. Administration of PHA after irradiation significantly increased the number of endogenous spleen colonies, and, at certain radiation doses, improved postirradiation survival. Administration of PHA before irradiation had no effect on the number of endogenous spleen colonies formed or postirradiation survival. (BBB)

10797 POSTIRRADIATION BEHAVIOR OF TRANSPLANTABLE SOLID TUMORS IN RELATION TO THE REGIONAL OXYGENATION. Reinhold, H. S. (Radiobiological Inst. TNO, Rijswijk,

Netherlands). pp 1482-6 of Proc. XIth Intern. Congr. Radiol., Rome, Sept. 1965. Amsterdam, Exerpta Medical Foundation, 1966.

In vivo survival of irradiated cells of rhabdomyosarcoma BA 1112 transplanted in rats was studied. The survival curve for this solid radioresistant tumor was made by a cell dispersion method using the enzyme trypsin and a mechanical stirrer to disperse the solid tumor tissue into isolated living cells, that were transplanted in definite numbers. Isologous transplantation of 30 cells from unirradiated tumors resulted in 50% tumor takes within 100 days. If the tumors were irradiated with different doses, the number of cells achieving 50% tumor takes was proportionally higher; for example, at the surviving level of 1%, 100 times this number, or 4000 cells, was needed. Since oxygenation of some parts of a tumor can be inadequate, all in vivo experiments were limited to the irradiation of small tumors. The survival curve obtained with these small tumors showed that about 15% of the living cells in these tumors are anoxic, and the radioresistance of this tumor can be partially explained by its high proportion of anoxic cells. Also investigated was the reaction of the blood vessel pattern of a tumor following a single dose of irradiation. In the non-necrotic parts of an unirradiated tumor, Rhodamine dye was found to be mixed with the blood in most blood vessels. About one week after a single dose of 2000 to 4000 R, a different pattern was observed in comparable areas (a few mm from the edge of the tumor). In some blood vessels, the dye was completely absent, suggesting a failure of the circulation through these vessels and several days later, such an area showed necrosis. Therefore, irradiation induces areas in the tumor where cells die an ischemic death. Extensive areas of tumor cells, that were protected against direct irradiation damage by anoxia, may die secondarily as a result of vascular insufficiency. Other investigations indicated that the blood supply of some areas of a tumor may improve following the first dose of irradiation. The remaining tumor cells may then show increased radiosensitivity to the succeeding dose of x rays. (BBB)

10798 PREOPERATIVE RADIATION THERAPY IN SIMULATED CANCER OF THE COLON IN RABBITS. Whiteley, Horace W. Jr. (Memorial Hospital, New York). Dis. Colon Rectum, 10: 100-2(Mar.-Apr. 1967).

Because of lack of specific data on the effectiveness of the clinical use of preoperative radiation therapy for cancer of the distal portion of the colon and rectum, an experimental plan was formulated by which the effects of radiation therapy administered prior to a surgical resection can be evaluated. The VX_2 carcinoma, a readily transmissible tumor of rabbits, was implanted subserosally into the colon of adult rabbits to produce a growth pattern and a natural course of disease, including local and distant metastasis, that simulate cancer of the colon in humans. Three treatment methods were evaluated: surgical resection alone, radiation therapy alone, and combined radiation therapy with subsequent surgical resection. The survival period in the resected animals was slightly, but not significantly, longer than that of the controls. Group 2 animals received a single (1000 R) 250-KV x irradiation at weekly periods after tumor implantation. The animals, treated after one week of tumor growth, had a significantly longer period of survival than the controls. In animals that underwent combined therapy, radiation was administered in the same manner as the 2nd group, as 1000 R in a single dose at weekly intervals from the time of implantation. Virtual cure was obtained during the study period in this group that received the radiation within a week of implantation and then underwent surgical resection. Histologic sections of irradiated tumor compared to nonirradiated implanted tumor in the colon did not disclose significant pathologic changes in the cellular structure that would account for the observed results. (BBB)

10799 TREATMENT OF OSTEORADIONECROSIS BY INTRAORAL EXCISION OF THE MANDIBLE. Marchetta, Frank C.; Sako, Kumao; Holyoke, E. Douglas (Roswell Park Memorial Inst., Buffalo, N. Y.). Surg. Gynecol. Obstet., 125: 1003-8 (Nov. 1967).

Surgical treatment for radiation injury of the jaw is reviewed, and for nine cases the surgical techniques are described. Osteoradionecrosis of the mandible in its most severe form was characterized by severe pain, trismus, fistula formation, difficulty in eating, inanition, and debility. Unless treated aggressively, the disease in this stage progresses and terminates in death. Severe osteoradionecrosis was successfully managed by surgical therapy. The interval between the administration of irradiation and development of osteoradionecrosis varied from several months to several years. Late radiation changes (fibrosis, telangectasia, atrophy of the skin, dryness of the mucous membranes) were evident in the overlying soft tissues. Four of the nine patients still had teeth. Only one of these had a tooth extracted prior to breakdown of the mandible. Alveolar abscess was present before extraction, and, although the sequence of events suggested that the extraction was responsible for the osteoradionecrosis, breakdown of the mandible was probably inevitable. The remaining five patients were edentulous. (BBB)

10800 REDUCTION OF DRY WEIGHT OF THE SMALL INTESTINE OF WHITE MICE AFTER COMBINED TREATMENT WITH HEMATOPORPHYRIN AND WHOLE-BODY IRRADIATION. Cittadini, G. (Univ., Siena, Italy). Boll. Soc. Ital. Biol. Sper., 42: 234-6(Mar. 15, 1966). (In Italian).

The effect of hematoporphyrin on intestinal weight loss resulting from ionizing irradiation was studied in mice of the NMRI strain. The dry weight of small intestine was examined 48 hr after an LD_{100} dose (800 R) of x rays. Some mice received intraperitoneal injections of 5, 15, or 45 mg/Kg hematoporphyrin. The dry weight of the small intestine was 233.0 mg in unirradiated controls, 171.1 mg in irradiated mice, and 148.8, 179.0, and 200.0 mg in irradiated mice receiving 5, 15, and 45 mg/Kg hematoporphyrin, respectively. It was evident that the lowest dose of hematoporphyrin significantly increased radioinduced weight loss, while the highest dose significantly reduced it. The possibility of altering the incidence of postirradiation intestinal death by hematoporphyrin is discussed. (BBB)

10801 HEMATOPORPHYRIN AND THE TEST OF POSTIRRADIATION SPLENIC REDUCTION. Cittadini, G. (Univ., Siena, Italy). Boll. Soc. Ital. Biol. Sper., 42: 239-41(Mar. 15, 1966). (In Italian).

Hematoporphyrin, previously shown to modify several reactions to ionizing irradiation, was tested for its ability to modify splenic weight reduction in whole-body irradiated animals. Mice of the NMRI strain were x irradiated with doses varying from 414 to 644 R and their spleen weights were determined 120 hr later. Some mice irradiated at the 506-R dose level were injected intraperitoneally with hematoporphyrin (5, 15, or 45 mg/Kg) 30 min before irradiation. Spleen weight in uninjected irradiated mice fell proportionately with dose, to 54.6 mg after 414 R, 48.4 mg after 460 R, 41.2 mg after 506 R, 35.7 mg after 552 R, 33.4 mg after 598 R, and 25.9 mg after 644 R. In the 5-, 15-, and 45-mg/Kg hematoporphyrin-treated mice receiving 506 R the spleen weights fell to 35.0, 45.4, and 48.6 mg, respectively. Thus the potentiating effects of these three doses of hematoporphyrin on x irradiation were 112.6, 93.6, and 87.7% respectively. However, none of the observed differences were statistically significant. (BBB)

10802 POSTIRRADIATION LEUKOPENIA AND PRETREATMENT WITH HEMATOPORPHYRIN IN WHITE MICE. Cittadini, G. (Univ., Siena, Italy). Boll. Soc. Ital. Biol. Sper., 42: 236-9(Mar. 15, 1966). (In Italian).

The radiosensitizing effect of hematoporphyrin, demonstrated previously by other indices, was tested by changes in leukocyte levels in irradiated mice. Animals of the NMRI strain, 2½ months old and weighing 24 g, were injected intraperitoneally with 5-, 15-, or 45-mg/Kg doses of hematoporphyrin and 30 min later given an 800-R whole-body dose of x rays. In nonirradiated controls, there was a slight rise in leukocyte levels after injection of the two highest hematoporphyrin doses. Irradiation alone caused a drop in leukocyte count to a mean of 543/mm^3 from 2428 in controls, 24 hr postirradiation. Progressively greater decreases of leukocyte levels were noted after injection of 5, 15, and 45 mg/Kg of hematoporphyrin, the corresponding levels being 525, 475, and 400/mm^3. However, none of the differences from control values were statistically significant, indicating a failure to demonstrate a radiosensitizing effect of hematoporphyrin on leukopenia. (BBB)

10803 SURGERY POSSIBILITIES FOR LARYNGEAL AND HYPOPHARYNGEAL CARCINOMAS AFTER TREATMENT WITH HIGH-ENERGY BETATRON ELECTRONS. Bozzi, E. (Tintori Ospedale, Monza, Italy); Cova, P. L.; Botti, G.; Tosi, G. Acta Oto-Laryngol., 62: 44-53(July 1966).

Radiation damage occurring in treatment of laryngeal neoplasias in 33 patients by high-energy electron beams (between 14 and 32 MeV) through a single anterior cervical field are described. Doses of ~7500 R over seven to eight weeks caused moderate atrophy of the cutaneous layer, moderate induration of the dermis, no apparent lesions of the osteocartilaginous tissues, and moderate atrophy of the laryngeal soft parts, causing practically no edema of the larynx. Ulcerated and infected ventricular tumors, and tumors of the glottic or anterior paraglottic regions having similar features and near the perichondrium, were more liable to develop perichondritic or chondritic necrosis with loss of fragments of the laryngeal shield. The hardening of soft parts, as a late change, was more marked when the single anterior irra-

diation field included the suprahyoid. Doses of ~8500 R over eight to nine weeks damaged the cutis (atrophy) and the dermis (induration) to a degree slightly greater than that described above, whereas no apparent injury to the cartilaginous part of the larynx was seen. Greater atrophy of the laryngeal soft parts was noted. Edema was more likely to arise at the aryepiglottic plicae and the paraglottic regions. Such late damage, however, was comparatively moderate and similar to that seen after conventional radiotherapy. Doses above 9000 and up to 10,000 R over nine to ten weeks, though increasing the late lesions mentioned above, did not cause late necrotic phenomena if the tumor was not originally ulcerated or infected. However, such doses were unlikely to heal a tumor that failed to respond sufficiently to the more customary doses of 7500 to 8500 R. In cases necessitating surgical intervention, it was essential to avoid administering doses over 8500 R. The interval between completion of radiotherapy and start of surgery in these cases ranged from 10 days to 12 months. Quite different from what was observed after conventional x-ray and ^{60}Co therapy, such widely different intervals did not result in significant postoperative hemorrhage and in wound cicatrization. However, the recommended interval between completion of radiotherapy and commencement of surgery is two to three months. Tissue damage, arising during this time, is usually moderate and causes no increased difficulty at operation. (BBB)

10804 REPORT ON THE WORK OF THE HIROSHIMA ATOMIC BOMB HOSPITAL. Shigehuji, Fumio (Atomic Bomb Hospital, Hiroshima). Nagasaki Igakkai Zasshi, 40: 689-9 (Aug. 1965). (In Japanese).

An outline of research and examination of patients in the Hiroshima Atomic Bomb Hospital from September 1956 to August 1964 is presented. The total patient examinations included 41,751 persons, i.e., about one-half of all the atomic bomb survivors in Hiroshima. In a study of possible radiation effects on the incidence of diseases in atomic bomb survivors, 71 cases of leukemia were studied. Leukemia incidence had decreased gradually since 1960. The incidence of other blood diseases had also decreased gradually since 1960. However, patients with malignant tumors, diabetes, hypertension, atherosclerosis, and central nervous system vascular disorders have increased. There were 281 cases of malignant tumor, among which 100 cases were of stomach cancer, the order of cancer incidence rate decreasing from lung, liver, breast, intestine, to lymphatic system malignancies. Most cases of leukemia, malignant lymphatic tumor, lung cancer, and stomach cancer were observed in the survivors who had been within a distance of 2 Km from the explosion, suggesting a correlation between the incidence of cancer and radiation exposure. A high incidence of leukemia was observed among the survivors in the 20 to 60 age group, and the male-to-female ratio was 1 : 0.76. Possible radiation effects in the atomic bomb survivors were also examined at autopsy. Among the probable radiation-induced diseases, leukemia showed the highest proportion of the total mortality. The other major causes of death are reported. (BBB)

10805 TREATMENT OF LEUKEMIAS BY RADIOISOTOPES. Najean, Y. (Hopital Saint-Louis, Paris). J. Radiol., Electrol., Med. Nucl., 48: 387-90(June-July 1967). (In French).

A bibliographic study was made of the use of radiophosphorus and radiocolloids (Mn, Au, Bi, Y, and P). Because of the extensive use of chemotherapy for the treatment of leukemias, there is a paucity of references. Whole-body irradiation by ^{32}P appeared to give a longer life span then other treatments. The selective irradiation by colloids fixed in the reticulo-endothelial system did not appear to give superior results to those obtained by chemotherapy. (J.S.R.)

10806 A PLAN FOR A RADIOISOTOPE DEPARTMENT FOR A LARGE GENERAL HOSPITAL. Clarke, K. H.; Milne, Jean (Cancer Inst., Melbourne). Australas Radiol., 11: 286-8(Aug. 1967).

A basic plan is presented that occupies a working area of 4,500 square feet and is designed to cope with a full range of in vivo and in vitro radioisotope applications. The department is designed as a full service unit to the hospital and does not preclude peripheral use of radioisotopes where such demand is reasonable. (auth)

10807 EXPOSURE TO RADIATION AND RADIATION PROTECTION. Sonnabend, Eberhard (Univ., Goettingen, Ger.). Deut. Zahnaerztl. Z., 22: 126-40(Feb. 1967). (In German).

The general radiation dose and the degree of exposure of the skin surface and the gonads of patients in the course of intra-oral and extra-oral x-ray diagnosis, including tomography, are reviewed. The radiation dose to which the dentist, his assistant, and personnel in their offices are exposed is also considered. The need for protection against radiation is commented on with regard to regulations for radiation protection which are still valid at present as well as on the draft of the new regulations for protection against injury from radiation. Mention is further made of the recently passed recommendations for radiation hygiene in dentistry in Germany. Various measures are suggested for the reduction of the radiation dose, and emphasis is placed on the dentist's duty to observe the regulations concerning protection against radiation. (BBB)

10808 STATISTICAL INVESTIGATION OF LEUKEMIA IN JAPAN. Tomonaga, Masanobu (Nagasaki Univ., Japan). N. Z. Med. J., 65: 863-9(Dec. 1966).

The incidence of leukemia in the Hiroshima and Nagasaki atom bomb survivors was contrasted to that of various other Japanese populations. Studies of the atomic bomb survivors revealed 419 leukemia cases in Hiroshima and 350 in Nagasaki. The type distribution of these 2 groups was shown. As to chronic lymphocytic leukemia, Hiroshima had 3 cases or 0.8%, and Nagasaki 8 cases or 2.3%. The 2.3% Nagasaki rate was almost identical with the average rate for Japan. The low occurrence rate of chronic lymphocytic leukemia in Asian countries including Japan has been known for many years, but the cause has not yet been clarified. In Japanese children under 14 yr of age, the incidence of acute leukemia was extremely high. The low incidence in children of the atomic bomb survivors was due to the fact that the population under the age of 19 was much smaller in the atomic bomb survivors. In the exposed group, more chronic granulocytic leukemias developed in the younger age group, especially in Nagasaki. The general leukemia experience in Hiroshima and Nagasaki during the 20 yr after the atomic detonations was reviewed. The γ-ray doses in Hiroshima and Nagasaki were almost the same, but the estimated dose for neutrons was greater in Hiroshima than in Nagasaki, so the data of both cities must be studied separately. The absolute number of leukemias in Hiroshima was much greater than that in Nagasaki, due to the fact that the population residing close to the hypocenter in Hiroshima was greater than that in Nagasaki. The incidence rates of the exposed group in Hiroshima and Nagasaki were almost the same; the highest incidence was observed from 1950 to 1952. It subsequently decreased, and in the last few years the incidence in all exposed groups has been at almost the same level as that of Japan. The incidence in those exposed at less than 1500 m was still high. The closer the distance of exposure, the shorter was the latent period. In both cities chronic granulocytic leukemias developed after slightly shorter latent periods than acute leukemias. The ratio of acute leukemia to chronic granulocytic leukemia in Hiroshima was very low among those exposed at a short distance. In Nagasaki, the ratio among those exposed under 1500 m was higher than that in Hiroshima, but much lower than that among those exposed at a greater distance or among the nonexposed. The incidence of acute leukemia was higher than that of chronic granulocytic leukemia in both cities. Assuming that leukemia arises from disorders of the processes of destruction and restoration of irradiated hemotopoietic tissues, acute leukemia mostly develops in hypoplastic marrow, while the chronic granulocytic type develops in hyperplastic marrow. The bone marrow probably became aplastic or hypoplastic immediately after exposure to the single whole-body irradiation of the atomic bomb, but subsequently focal hyperplasia occurred, from which chronic granulocytic leukemia developed. The difference in the neutron dose might explain the higher incidence of chronic granulocytic leukemia in Hiroshima. (BBB)

10809 MENTAL RETARDATION IN CHILDREN EXPOSED IN UTERO TO THE ATOMIC BOMBS IN HIROSHIMA AND NAGASAKI. Wood, James W.; Johnson, Kenneth G.; Omori, Yoshiaki; Kawamoto, Sadahisa; Keehn, Robert J. (Atomic Bomb Casualty Commission, Hiroshima). Amer. J. Public Health, 57: 1381-90(Aug. 1967).

A group of 1613 children who were in utero at the time of the atomic bombing of Hiroshima and Nagasaki was evaluated for mental retardation in terms of exposure distance and gestational age. For each city the more distal (3000 to 4999 m) and not-in-city subjects were matched by gestational age and sex to the proximal group (within 2000 m). The subjects were submitted yearly to physical examination, anthropometric measurements, routine tests on blood, urine and stool, and any additional procedures indicated. At some examinations other specific tests including psychrometrics were done. Of the 1613 subjects in the sample, 30 had gross mental retardation. Within 1500 m from the hypocenter the prevalence of mental retardation was five times as high as for the more distal subjects. Even when subjects with possible explanations for their retardation were excluded, the pattern of differences remained the same. All but two of the retarded subjects had smaller than average heads and for those who were within 1500 m this effect was accentuated. However, mental retardation was not always found in those with small heads. The

causative factors involved in the development of small heads and those leading to mental retardation may be, to some degree, independent. General head size limitation was observed for all stages of gestation for those within 1500 m, while six to 15 weeks gestation proved to be the most sensitive time for the development of mental retardation, suggesting a differential radiosensitivity for calvarium and brain. (BBB)

10810 INFLUENCE OF HYDROCORTISONE ON ERYTHROPOIESIS OF NORMAL AND IRRADIATED RATS. Travnicek, T.; Neuwirt, J.; Janousek, V.; Broulik, P.; Taborsky, J.; Taborska, E. (Charles Univ., Prague). Sb. Lek., 68: 109-12(1966). (In Czech).

The effects of hydrocortisone on erythropoiesis in irradiated rats were investigated. Wistar rats, weighing 210 g, were divided into four groups of 18 animals each. The first group served as controls, while the rats of the second group were administered daily by the subcutaneous route 1 mg hydrocortisone acetate per 100 g body weight. The animals of the third and fourth group were exposed to a single whole-body dose of 600 R, and the animals of group 4 also were given hydrocortisone, as in group two. On the 3rd, 7th, and 14th day, 6 rats from each group were killed and examined. Data are given for body weight, hematocrit, hemoglobin, peripheral erythrocytes and reticulocytes, and ^{59}Fe uptake in circulating erythrocytes and in bone marrow in four different sites. The results showed that for each of the three examination periods hydrocortisone reduced the body weight of experimental rats, did not stimulate erythropoiesis in normal rats, and caused a deterioration of erythropoiesis in irradiated rats. The observed changes in the number of red cells after hydrocortisone on the first days of administration were probably due to changes in the distribution and circulation of blood. (BBB)

10811 RADIOPROTECTION OF VICIA FABA BY SEROTONIN-CREATININE SULFATE COMPLEX. Villalobos-Pietrini, R.; Laguarda-Figueras, A. (CNEN, Mexico City. UNAM, Mexico City). Radiat. Bot., 7: 369-73(Oct. 1967).

Experiments were performed to test if serotonin-creatinine sulfate complex (S-CS C) decreases the lethal effects of x rays on Vicia faba. This substance was found to protect mammals against ionizing radiations, in which serotonin's mechanism of action is purported to be due to vasoconstriction, thereby decreasing the oxygen tension inside the tissues. This hypothesis cannot explain the radioprotective effects in plants. Reducing agents containing sulfur groups have been previously shown to be effective radioprotectors. An electron donor mechanism, as well as formation of radioresistant complexes with radiosensitive sites, interference with biochemical reactions, or scavenging of free radicals, might explain the radioprotection effectiveness of serotonin-creatinine sulfate complex in plants. At this stage of the studies, however, none of these possibilities can be considered sufficient explanation of the results obtained. (auth)

10812 DIAGNOSTIC VALUE OF THE ^{131}I-LABELLED TRIIODOTHYRONINE RED BLOOD CELL UPTAKE TEST. Banos, Cs.; Tako, J.; Rado, J. P.; Krasznai, I.; Goschl, Irma (Janos Hospital, Budapest). Nucl.-Med., 6: 124-39(July 15, 1967).

The results obtained with the use of ^{131}I-labeled triiodothyronine in vitro red blood cell uptake test (RCU) on 614 patients were statistically analyzed and compared to other thyroid function tests (protein-bound iodine, plasma activity tests, thyroid ^{131}I uptake). The diagnostic accuracy of the RCU was quite satisfactory: 84% in euthyroidism, 92% in hyperthyroidism and 78% in hypothyroidism. The RCU test proved to be useful in the determination of thyroid status in patients pretreated with organic or inorganic iodine as well as in following the effects of both antithyroid and substitutional therapies. It has been found in the in vitro studies that the storage of the radioactive material causes a progressive decrease in the results of the RCU, presumably due to decomposition of the $^{131}I-T_3$ molecule. The differences in the methods, the normal ranges and the diagnostic accuracies reported by other authors have been reviewed. (auth)

10813 A COMPARISON OF THE RED CELL UPTAKE OF $^{131}I-T_3$ AND $^{125}I-T_3$ AS A TEST OF THYROID FUNCTION. Bell, T. K.; Todd, S. J. (Royal Victoria Hospital, Belfast). Nucl.-Med., 6: 121-3(July 15, 1967).

Investigation of the in vitro red cell uptake of triiodothyronine as a test of thyroid function showed that there was no significant difference when fresh saline dilutions of ^{125}I-triiodothyronine were used in place of ^{131}I-triiodothyronine. (auth)

10814 THE DISTRIBUTION OF ^{131}I LABELED DIETHYLSTILBESTROL DIPHOSPHATE IN ANIMALS AND MEN WITH OBSERVATIONS ON ITS POTENTIAL USE AS A SCANNING AGENT OF THE PROSTATE. Tubis, Manuel; Endow, John S.; Blahd, William H. (Veterans Administration Center, Los Angeles. Univ. of California, Los Angeles). Nucl.-Med., 6: 184-202(July 15, 1967).

The distribution of ^{131}I-labeled diethylstilbestrol diphosphate in the tissues of mice was found to be qualitatively similar to that of ^{14}C-labeled and ^{32}P-labeled diethylstibestrol diphosphate. A large percentage of the material is accumulated in the liver, from which it is excreted both via the bile and the gastrointestinal tract and kidneys. The concentration of the drug varied little, and tended to be lowest, in the prostate gland, testes, and adjacent tissues. The thyroid showed no large accumulation of radioiodide from the compound. The distribution of the drug in dog tissues was qualitatively similar to that in mice tissues. The concentration of the drug in a dog's prostate was delineated by scanning after the gland was located by palpation. The same region of the prostate was later rescanned after care had been taken to expose the prostate and to cover the bladder with sufficient lead. The concentration in human prostatic and testicular tissue was found to be similar to that previously reported for diethylstilbestrol and ^{32}P-labeled diethylstilbestrol diphosphate. The possibility exists that the radiation from the labeled drug deposited in the prostate might affect tumor cell growth despite the very low concentration. Scanning of the prostate is complicated by the accumulation of radioactivity in the bladder and colon. (auth)

10815 EFFECT OF DEFICIENCY OF VITAMINS OF THE B GROUP ON THE RADIATION SENSITIVITY AND RECOVERY OF IRRADIATED YEAST CELLS. Seliverstova, L. A.; Meisel, M. N. Radiobiologiya, 7: 361-6(1967). (In Russian).

Experiments conducted with Torulopsis sphaerica 447, Saccharomyces lactis, and Saccharomyces carlsbergensis 4228 cultures indicated that vitamin deficiency (nicotinic acid, biotin, pyridoxine, and thiamine) considerably increased the radiosensitivity of the yeast cultures. The radiosensitivity of Saccharomyces carlsbergensis was particularly increased by a lack of pyridoxine that is critical for its development. Vitamin deprivation increased the radiosensitivity of T. sphaerica to a level approaching that of warm-blooded animals, i.e., this species of yeast could be used in model experiments involving correlation of data on the action of radiation on animals. (JPRS)

10816 STUDY OF THE PROTECTIVE EFFECT OF β-MERCAPTOETHYLAMINE IN EXPERIMENTS ON FROGS (CONCERNING THE PROBLEM OF THE METHOD OF ESTIMATING THE EFFECTIVENESS OF RADIOPROTECTIVE AGENTS). Bychkovskaya, I. B.; Strelkov, R. B. Radiobiologiya, 7: 452-4(1967). (In Russian).

Rana temporaria were x-irradiated at 200, 300, 500, 600, 700, 800, and 900 R doses. Twenty minutes before irradiation, the frogs received an intraperitoneal injection of cysteamine in a dose of 300 mg/kg. Cysteamine exerted a definite protective effect in reducing the deathrate of irradiated frogs. However, a zone of saturation at 500 to 900 R was observed that corresponded to a mean life-span for surviving animals of about 40 days. On irradiation with 500 to 700 R, 30 to 50% of the irradiated frogs injected with cysteamine survived as compared to zero for the controls. On irradiation with 800 to 900 R frogs previously injected with cysteamine were not protected. This indicated that the factor of dose reduction was ≤ 1.75. In work carried out by other investigators irradiation was carried out at doses that were too high, so that the conclusion was reached to the effect that cysteamine did not protect frogs against radiation. In estimating the effectiveness of agents protecting against radiation, the existence of a saturation effect and the stepwise nature of radiation damage to experimental animals, such as frogs, must be taken into consideration. (JPRS)

10817 INHIBITION OF THROMBOHEMORRHAGIC PHENOMENA BY "OVERSENSITIZATION." Selye, H.; Rohan, P.; Winandy, G. (Univ. of Montreal). Int. Arch. Allergy Appl. Immunol., 30: 575-88(1966).

Experiments with rats indicated that certain variants of the thrombohemorrhagic phenomenon (THP) of Thorotrast (ThO_2) that can be elicited by simultaneous administration of Thorotrast and other sensitizing and challenging agents failed to develop when an excess of the sensitizers was administered. Some degree of this oversensitization could also be demonstrated in rats sensitized with various carrageenans and challenged with adrenaline, but the degree of protection was much less pronounced. The THP produced after sensitization by combined treatment with tannic acid plus Thorotrast and challenge by cold or sensitization with indium chloride and challenge by adrenaline was not inhibited, even when near lethal amounts of ThO_2 and the other sensitizers were given. The protection afforded by oversensitizing doses of the potential sensitizer was administered simultaneously or at least within a few hours; however, under these conditions the development of lesions was permanently prevented. (BBB)

10818 SURVEY OF RADIATION EFFECTS IN EXPOSED ISLANDERS. Kumatori, Toshiyuki. Nagasaki Igakkai Zasshi, 40: 702-3(Aug. 1965). (In Japanese).

Sequelae of irradiation as the result of the nuclear weapons test near Bikini on March 1954 were observed in 23 Japanese fishermen and about 200 native islanders. Radiation exposures from fallout included the generalized external exposures due to γ rays, skin exposures from β rays, and the internal exposure due to the absorbed radionuclides. The doses received by 54 islanders were considered to be 175 R and for the Japanese fishermen 200 to 600 R in 14 days. A survey of the radiation effects was conducted on 190 islanders among which 45 were exposed persons and the remainder controls. The early radiation-induced disturbances that were noted included skin diseases, neutropenia, and lowered lymphocyte counts. However, there were no cases of skin cancer or leukemia. On the other hand, two 1-yr-old exposed infants showed growth stunting and three 2- to 4-yr-old girls showed thyroid disturbances. Examination of the exposed subjects by whole-body counting $3\frac{1}{2}$ yrs postexposure revealed that radiocesium and radiozinc burdens were elevated. (BBB)

10819 TUMOR LOCALIZING AGENTS. II. RADIOIODINATED ANALOGS OF 1,1-DICHLORO-2,2-BIS(CHLOROPHENYL)ETHANE. Counsell, R. E.; Willette, R. E.; DiGuilio, W. (Univ. of Michigan, Ann Arbor). J. Med. Chem., 10: 975-7(Sept. 1967).

The synthesis and tissue distribution of some radioiodinated analogs of 1,1-dichloro-2,2-bis(chlorophenyl)ethane(DDD) are reported. Interest in structures related to DDD was prompted by reports that indicated a predilection of these substances for adrenal tissue; o,p'-DDD caused necrosis of certain regions of the adrenal cortex in dogs, produced tumor regression in metastatic adrenal cortical carcinoma, and caused remission of symptoms in patients with Cushing's syndrome. Iodine-125 was selected in preference to ^{131}I for labeling of the analogs because its longer half-life (60 vs 8 days) and lower radiation energy (35 vs 360 KeV) simplified synthesis and storage of the products. Synthesis of o,p'-, m,p'-, and p,p'-DDD was followed by isotope exchange to introduce ^{125}I into the isomeric iodo compounds. This was achieved by heating the appropriate isomer with $Na^{125}I$ in ethylene glycol at 180°, giving ~50% exchange within 12 hr. The rate of exchange was followed by radioscanning of thin layer chromatograms. Preliminary tissue distribution data for the three ^{125}I-labeled analogs of DDD were obtained in male rats. The general order of concentration at 4 hr was adrenal > fat > liver and other tissues. By 24 hr, the order was found to be fat > adrenal > liver and other tissues. (TSS)

10820 TUMOR LOCALIZING AGENTS. III. RADIOIODINATED QUINOLINE DERIVATIVES. Counsell, R. E.; Pocha, P.; Morales, J. O.; Beierwaltes, W. H. (Univ. of Michigan, Ann Arbor). J. Pharm. Sci., 56: 1042-4(Aug. 1967).

Radiolabeled compounds having affinity for melanin were sought in attempts to develop new diagnostic and therapeutic agents for malignant melanoma. The approach to this problem involved the synthesis of radiolabeled compounds that would selectively localize in these tumors. To achieve this tumor selectivity, the initial selection of compounds of two categories for radiolabeling were studied, namely, precursors of melanin and compounds that were known to interact with melanin. The fact that chloroquine had a marked affinity for melanin and was slowly released from pigmented tissues prompted attempts to synthesize radioiodinated analogs of chloroquine and to study their distribution in mice with transplanted melanomas. The key intermediate, 4-chloro-7-iodoquinoline, when refluxed with 3-dimethylaminopropylamine gave the desired chloroquine analog, 4-(3-dimethylaminopropylamino)-7-iodoquinoline, in 65% yield. Iodine-125 or ^{131}I was introduced into this chloroquine analog by isotope exchange with radioiodide in ethylene glycol at 175°. By this procedure the ^{125}I- and ^{131}I-labeled compounds were obtained with specific activities of 2.03 and 1.42 mCi/mole, respectively. The radiolabeled compounds were purified by recrystallization and analyzed by thin layer chromatography. The distribution of activity of the radioiodinated analog of chloroquine was similar to that seen with chloroquine in rats and chloroquine-^{14}C in mice. Moreover, the low thyroid activity observed for the animals receiving the radioiodinated compound as compared to those given radioiodide indicated that significant deiodination did not occur. (BBB)

10821 APPARATUS FOR RADIATION THERAPY OF DISEASED TISSUES WITH MINIMUM EXPOSURE TO HEALTHY TISSUES. Braestrup, Carl B. U. S. Patent 3,349,242. Aug. 7, 1964.

An apparatus is described for radiation therapy comprising, an arcuately curved element having vertical and horizontal axes the latter being disposed perpendicularly to the plane of the element, a source of radiation fixed near one end of the curved element, a beam shield attached to the element opposite the source, means for imparting rotative motion to the element around its horizontal axis, means for imparting rotative motion to said element around its vertical axis, a base in alignment with the source and shield, and means for mounting the curved element on the base. (auth)

Radiation Effects on Animals

Refer also to abstracts 10197, 10674–10678, 10680, 10682–10684, 10691, 10692, 10699, 10715, 10716, 10726, 10732, 10738–10741, 10744, 10745, 10748, 10751, 10757, 10760, 10764, 10778, 10780, 10783, 10787–10789, 10792, 10794, 10796, 10797, 10799–10802, 10804, 10808–10810, 10816, and 10818.

10822 (AECD/AG-22) THE SUSCEPTIBILITY OF THE DIFFERENT STAGES OF RICE WEEVIL, SITOPHILUS ORYZAE L. TO GAMMA RADIATION. Khan, Zainul Abedin; Matin, A. S. M. Abdul (Atomic Energy Centre, Dacca (Pakistan). Agriculture Div.). May 1967. 15p. Dep.

The effects of gamma radiation from a ^{60}Co source on all the developmental stages of rice weevil, Sitophilus oryzae L were studied. Complete mortality of eggs was obtained by 2,500R, of larvae by 8,000R, of pupae by 10,000R and of adults by 12,000R. Production of progeny was stopped at 9,000R in all the developmental stages. Twelve thousand R might be considered as minimum effective dose for the control of S. oryzae L. (auth)

10823 (ATD-66-133) SOVIET RESEARCH ON THE NEURAL EFFECTS OF MICROWAVES. Dodge, Christopher; Kassel, Simon (Library of Congress, Washington, D. C. Aerospace Technology Div.). Nov. 7, 1966. 33p.

Included in the report are Soviet open sources published from 1952 to 1966 with a few sources published earlier. Its primary purpose is to outline Soviet research on the effect of low-intensity microwave radiation on the central nervous system of living organisms, including man. There are six sections in the report: scope of efforts, including organizations and individual researchers, subject development, specific neural functions and structures, in vivo neural effects, neural effects of low-frequency electromagnetic and magnetic fields, and clinical, therapeutic, and hygienic aspects. Each of these sections may be read independently. The discussion that follows summarizes important facts and deductions from the foregoing sections and speculates on the intensity and type of Soviet research efforts in this area in the future. The bibliography at the end of the report includes 42 entries. (auth) (ATD)

10824 (BNWL-480, pp 1-19) RADIATION EFFECTS: GENERAL. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The data are presented on the mechanism and treatment of gastrointestinal radiation effects. Three papers are presented on the effects of x radiation on sodium, water, and electrolyte transport and vitamin B_{12} sorption in the intestines of rats; two papers discuss the effects of x radiation on larval and pupal stages of flour beetles; and one paper each is given on the effects of dimethyl sulfoxide treatment of seeds on growth of the plant and the use of thorium containing stains for localization of acid mucopolysaccharides in the golgi complex of intestinal cells in rats and miniature swine. (E.R.B.)

10825 (BNWL-480, pp 55-83) INHALATION STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Effects of chronic inhalation of radioactivity are reported. Biochemical and ultrastructural effects of plutonium inhalation on lungs and the relation between lymphopenia, taurine excretion, and pulmonary irradiation are considered. In the long-term inhalation studies in beagles, primary lymphatic tumors in lungs and lymph nodes were noted for the first time. (E.R.B.)

10826 (MIT-952-4) RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Annual Progress Report. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics). May 1967. Contract AT(30-1)-952. 438p. Dep. CFSTI.

Separate abstracts were prepared for the six sections of this report. (S.F.L.)

For abstracts of individual sections see: 10355, 10541, 10760–10762, and 11947.

10827 (UCD-472-114) ANNUAL REPORT, FISCAL YEAR 1967. (California Univ., Davis. Radiobiology Lab.). June 1967. Contract AT(04-3)-472. 88p. Dep. CFSTI.

X RADIATION — effects on female beagle dogs, effects of dose fractionation on whole-body

DOGS — mammary tissue from beagle, ultrastructure of neoplastic and normal cells of; pathology of liver in female

beagle, effects of age on; radiation effects on production of litters by female beagle, β and x
GAMMA RADIATION—effects on bones, eyes, and feet of beagle dogs
BETA PARTICLES—effects on bones, eyes, and feet of beagle dogs; effects on pre-weaning mortality in beagle dogs, effects of exposure during gestation and lactation on
RADIUM-226—uptake and retention by beagle dogs following oral administration
BARIUM-133—uptake and retention by beagle dogs following oral administration
GAMMA RADIATION, BETA PARTICLES—effects on content of hematopoietic tissues in beagle dogs, effects of dose rate on
BEHAVIOR—analysis in castrated beagle dogs
DISEASES, NEOPLASTIC—leukemia, radioinduced, in beagle dogs, effects of continuous exposure on β
RADIATION DOSIMETERS, THERMOLUMINESCENT—performance of implanted, for dosimetry in beagle dogs
STRONTIUM-90—uptake by dogs, in relation to content of hydroxyproline in urine and to development of bones
LYMPHOCYTES—radiation effects on survival and transforming ability of, in beagle dogs, x
FALLOUT—content of beagle dogs in California, effects of Chinese nuclear testing on
DATA RECORDING SYSTEMS—design for use with whole-body counters
WHOLE-BODY COUNTING—calibration of standards for, of strontium-90 bremsstrahlung in experimental animals
DECONTAMINATION—radioactive waste, following disposal from beagle colony (E.R.B.)

10828 A METHOD FOR SELECTIVE TISSUE OXYGENATION UTILIZING REGIONAL INTRA-ARTERIAL INFUSION TECHNICS. Balla, G. A.; Finney, J. W.; Mallams, J. T. (Baylor Univ., Dallas). Amer. Surg., 29: 496-8(July 1963).

A method for enhancing the effectiveness of radiotherapy is presented whereby regional oxygenation is accomplished utilizing regional intra-arterial infusion techniques. By this method the venous oxygen saturation in the regional venous system can be raised 10 to 20%. Previously this necessitated the respiration of pure oxygen in a pressure chamber to deliver the oxygen at 3-atm pressure. The disadvantages of this method are readily apparent. The increase in radiosensitivity of tumors when the available oxygen is raised is considered, and studies on rats implanted with Walker 256 carcinosarcoma were made. The results suggested an enhanced effect on the tumors treated with hydrogen peroxide infusion followed immediately by irradiation, compared to the tumors treated only with irradiation or by irradiation followed by an infusion with hydrogen peroxide. Other studies were carried out in patients with tumors known to be sensitive to irradiation. These patients were treated with a hydrogen peroxide infusion and then irradiated with 50% of the usual dose used to treat the lesions. These cases were predominantly epidermoid carcinomas of the head and neck in which a maximum lethal dose had been well established. Results in 30 patients suggested that there is biologic enhancement by this technique permitting less radiation for the control of some epidermoid carcinomas; with other tumors normally not sensitive to irradiation, some showed dramatic regressions. (BBB)

10829 QUANTITATIVE MEASUREMENT OF REGIONAL COLON BLOOD FLOW IN THE NORMAL AND PATHOLOGICAL HUMAN BOWEL. Bacaner, Marvin B. (Univ. of Minnesota, Minneapolis). Gastroenterology, 51: 764-77(Nov. 1966).

The effect of ^{60}Co γ irradiation of the bowel on colon blood flow was determined in women with cervical cancer by a new radioisotope technique. It yielded a quantitative estimate of regional blood flow while the concentration of circulating tracer in arterial blood and the cumulative concentration of the tracer in a geometrically definable region of the gut was simultaneously determined. A special G-M detector, connected to a counting ratemeter and recording continuously on an oscillograph, was passed into the lumen of the gut and a bolus of ^{32}P solution was injected into a vein. The detector in the gut registered the activity contained within a 4-mm tissue shell surrounding its active length. This distance was ~ equal to the average thickness of the gut wall. Since radioactivity in adjacent loops could not be detected, a useful geometry is defined. Clinical observations indicated that acute radiation injury produced an increase in colon blood flow associated with the inflammatory phase of radiation colitis. Healing, on the other hand, was associated with a net decrease in colon blood flow below the control value. Moreover, the finding that water loading no longer augmented local colon flow despite an increase in cardiac output suggested that the vascular bed was reduced by scar tissue formation. Sigmoidoscopic examination showing diffuse pale patches supported this conjecture. While the colon blood flow generally increased during the inflammatory phase of acute irradiation injury, it was decreased in several patients. (BBB)

10830 RADIATION THERAPY OF POLYCYTHEMIA RUBRA VERA (VAQUEZ, OSLER). Ruckensteiner, E. (Univ., Innsbruck). Wien. Klin. Wochensch., 79: 772-4(Oct. 20, 1967). (In German).

Prior to the use of ^{32}P for treatment of polycythemia rubra vera, a total of 3000 R of x irradiation delivered in fractionated doses of ~25 R was recommended. The specific effectivity of ^{32}P for treatment is based on its rapid uptake by proliferating bone marrow cells that results in increased irradiation effectively. The enhanced radiosensitivity of the diseased marrow cells contributes to the effectivity of the ^{32}P incorporated. Overdoses of ^{32}P may result in increased incidence of leukemia or leukopenia. (BBB)

10831 EXPERIMENTS IN THE ARTERIOGRAPHIC VISUALIZATION OF THE MANDIBULAR ARTERY. Brachmann, Franz (Univ., Munich). Deut. Zahnaertztl. Z., 22: 192-6(Feb. 1967). (In German).

The anatomical relations between the various branches of the vascular tree in the mandibular area are described. The question of tumor growth and limitations in this area with particular reference to secondary vascular changes in the bones after x irradiation in patients of various ages is discussed. Superposition of compact bone in the region of the linea obliqua interferes with visualization of the inferior alveolar artery. Susceptibility of the mandible to radiation damage and osteomyelitis varied with the visualizability of vessels and the relatively poor vascularity of this skeletal area. However, impaired vascular visualization related to advanced age of the patient or to the interruption of a vessel filled with contrast medium in mandibular fractures was not observed. (BBB)

10832 TREATMENT OF LUNG METASTASES IN CHILDREN WITH COMBINED THERAPY: SURGERY AND/OR IRRADIATION AND CHEMOTHERAPY. Cliffton, Eugene E.; Pool, John L. (Memorial Sloan-Kettering Cancer Center, New York). J. Thorac. Cardiovasc. Surg., 54: 403-21(Sept. 1967).

Use of radiation combined with other treatments in children with secondary lung tumors is reported, along with an account of precautions used to prevent lung injury and its occurrence. Also reported is a fatality resulting from a radiotherapy-induced tumor. This patient lived 5 yr after treatment of pulmonary metastasis, only to succumb to a new sarcoma arising in the chest wall apparently as a result of irradiation. The 2-yr-old patient had been treated with radiation therapy for a pulmonary metastasis, receiving a tumor dose of 2500 R with 1000-KV x rays. There was no obvious change in the lesion as the result of the irradiation therapy. Seven months later chest biopsy revealed a sarcoma. An attempt at resection of the chest wall tumor was made, but could not be completed. The pathologic report was chondrosarcoma, considered to be consistent with irradiation-induced sarcoma. After a thorough pathologic review, it was maintained that this was an entirely different tumor from the metastatic rhabdomyosarcoma. This patient's course demonstrated two of the possible complications of preoperative irradiation therapy: one, atelectasis or pulmonary fibrosis, and the other, irradiation-induced sarcoma that was fatal. (BBB)

10833 OVARIAN DISLOCATION IN SURGERY OF UTERINE CARCINOMA. UPWARD DISPLACEMENT OF THE OVARIES FOR IRRADIATION OF THE PARAMETRIUM FOR UTERINE CARCINOMA. Kostic, Petar (Hospital for Women's Diseases and Obstetrics, Belgrade). Arch. Gynaekol., 204: 33(1967). (In German).

Displacement of the ovaries from the irradiation area was required for postoperative x irradiation of the uterine parametria. When the radiotherapy was administered, the surrounding areas were protected from irradiation by shielding with Pb plates. Cytohormonal follow-up studies indicated evidence of reduced ovarian function, probably caused by altered blood supply and also because of small amounts of irradiation received by the ovaries in spite of the radioprotective measures taken at the time of ovarian displacement. However, the follow-up studies have never, so far, indicated any evidence at all of metastatic tumors in the ovaries that were displaced during the irradiation treatments. (BBB)

10834 HYPOTHYROIDISM CONSEQUENT TO TREATMENT OF BASEDOW'S DISEASE WITH RADIOIODINE. Giustina, G.; Valentini, F.; Cantalamessa, L.; Reschini, E.; Lodeserto, A. (Univ., Milan). Folia Endocrinol (Pisa), 19: 34-47(Feb. 1966). (In Italian).

A survey was made of the authors' cases as well as of 16 other reports in the literature relating to the incidence of hypothyroidism as a complication of the ^{131}I treatment of hyperthyroid-

ism. The data were examined in terms of patients receiving ^{131}I doses calculated to give <10,000, 10,000 to 15,000, and >15,000 rad to the thyroid. The incidence of hypothyroidism was low in the authors' patients treated with ^{131}I; only two of 125 patients were permanently hypothyroid 1 to 6 yr after therapy. Permanent hypothyroidism was observed only in patients treated with doses higher than 15,000 rad. Transient hypothyroidism was observed in nine patients; in seven of them the ^{131}I dose was higher than 10,000 rad. Late hypothyroidism was never observed. The goiter was usually diffuse and the weight of the thyroid did not exceed 50 g in patients with hypothyroidism, permanent or transient. Age, sex, number of the doses, and serum antithyroglobulin antibody titer were not related to the onset of hypothyroidism. A greater incidence of hypothyroidism, up to 28%, found in other series, and the possible reasons for the low incidence in the authors' patients are discussed. (BBB)

10835 RADIATION EFFECTS, RADIATION INJURIES, AND RADIATION PROTECTION. Seelentag, Walter (Bundesgesundheitsamt, Berlin). Lebensversicherungsmedizin, 18: 120-32 (Oct. 4, 1966). (In German).

Radiation effects are classified into somatic, somatic-stochastic, and genetic types. Somatic effects included tissue defects and necroses that resulted from over-exposure to irradiation, growth inhibitions resulting from irradiation in utero or for various diseases, and injuries resulting from occupational exposure to x radiation. Incidences of leukemia in Japan are compared with respect to dose for normal and irradiated populations. Included under somatic-stochastic irradiation effects are the nonspecific life-shortening effects of radiation. The genetic effects of radiation exposure that are discussed include effects observed in experimental animals and plants, the recessive nature of mutations, and general mechanisms of effects of radiation on chromosomes. The legal standards established for radioprotection in various populations and occupations are discussed briefly. (BBB)

10836 THE EFFECT OF EMBRYONIC X IRRADIATION ON THE APPROACH AND FOLLOWING RESPONSE IN NEWLY HATCHED CHICKS. Strobel, Michael G. (Dalhousie Univ., Halifax, Can.); Baker, Donald G.; MacDonald, Glenn E. Can. J. Psychol., 21: 322-8(Aug. 1967).

Chicken embryos were treated with 200- or 400-R doses of x radiation at either day 2 or 9 of embryonic development. The hatched chickens were first exposed to an imprinting stimulus at 10 or 100 hr after hatching and their approach behavior was compared to that of untreated controls. There were significant differences between the early and late imprinting groups. Imprinting scores for those chicks x-irradiated on day 9 of incubation and given early imprinting experience were significantly lowered. These results suggested that radiosensitive central nervous system structures important to imprinting were being formed in the embryo on about day 9 of incubation and that these constitute a factor related to the offset of the sensitive period. (BBB)

10837 PATHOLOGICAL STUDIES OF RADIOACTIVITY EFFECTS IN BODY DISTURBANCES. II. THE HAMSTER SPINDLE TUMOR INDUCED BY THOROTRAST. Mori, Takesaburo; Sakai, Toshiharu; Okamoto, Takasi; Okamura, Nobuo; Nosue, Takenobu; Ishida, Tadasi; Umeda, Makoto (Yokohama City Univ., Japan). Nippon Byori Gakkai Kaishi, 54: 226-7(1965). (In Japanese).

Thorotrast (ThO_2)-induced spindle cell tumors were studied. A 0.1 to 0.6 ml dose of Thorotrast was injected into 20 adult Syrian hamsters. Eight animals developed the spindle cell tumors and 14 animals survived >250 days after injection. The tumor developed 270 to 472 days after ThO_2 injection and death occurred 33 to 45 days after development of the tumor. The estimated tissue dose of radiation from Thorotrast injection up to the time of tumor occurrence was 1500 to 2200 rad. The tumor was grayish white and hard, and was formed from the spindle cells, with proliferation of collagen and reticular fibers. Electron microscopic examination showed clearly the nucleolus, mitochondria, vacuoles, and collagen fibers. However, no virus-like substance was seen. Histochemical tests on the tumor showed the presence of acid phosphatase and absence of alkaline phosphatase and succinic dehydrogenase. The tumor could be transferred by subcutaneous, intravenous, or intraperitoneal injections, and developed in the lungs, liver, and lymph nodes. The probability of take was 100%. The tumor cells could survive at +5° or at −15°C in the frozen state for one week. However, after filtration of tumor cells through a 0.45 μ pore dia filter or ultrasonic treatment for 30 min the tumor cells were no longer viable on transplantation. (BBB)

10838 LASER-INDUCED EAR DAMAGE. Kelemen, George (Univ. of Southern California, Los Angeles); Laor, Yona; Klein, Edmund. Arch. Otolaryngol., 86: 603-9(Dec. 1967).

Mice (Swiss Ha/ICR and C57 Springville strain) were exposed to pulsed ruby and neodymium laser irradiation of the head. Exposed sites included the depilated forehead, the intact (nondepilated) region of the external ear, and surgically exposed sites on the skull. The gross results varied with the energy density. With levels of 100 J or more per cm^2, at 6943 Å or at 10,600 Å, the immediate mortality rate was close to 100%, frequently accompanied by bleeding from the ears, nose, or mouth. At 50 J/cm^2 at 6943 Å, the survival time ranged up to three days. Marked aberrations of neurological and behavorial reactions were evident during the survival period. Severe intracranial injuries and neurological and behavorial aberrations were evident in 46% of the animals. Damage to the ear was present and was on an all or none basis. Since the skin and bones were relatively uninjured, it was evident that secondary effects can be more severe at a deeper level than those produced at the superficial site of interaction. These preliminary explorations indicated a high potential hazard of laser radiation to the ear. (BBB)

10839 THE CURRENT STATUS OF KNOWLEDGE OF THE EFFECT OF IONIZING RADIATION ON THE HUMAN ORGANISM. Hug, O. (Univ., Munich). Deut. Zahnaerztl. Z., 22: 102-3(Feb. 1967). (In German).

The effects of ionizing radiation on the gastrointestinal tract, hematopoiesis, and the reproductive cells are reviewed and discussed in relation to dose and dose fractionation, oxygen abundance, and the mitotic activity of the cells. The use of chromosomal analysis as a form of biological dosimetry is also discussed. It was concluded that there was no indication of any causal connection between cytogenetic changes and the appearance of late radiation injuries such as leukemia and other malignant and degenerative diseases. (BBB) (TSS)

10840 INDUCTION OF HEPATOMAS IN THE MOUSE BY NATURAL RADIOACTIVITY: PRELIMINARY RESULTS OF A HISTOLOGICAL AND ELECTRON-MICROSCOPE STUDY. Chevrel, M.-L.; Pincet, J.; Toujas, L.; Guelfi, J.; Ferrand, B.; Richier, M. E. (Centre Anticancereux, Rennes, France). Bull. Cancer, 54: 7-32(Jan.-Mar. 1967). (In French).

Previously reported claims of a higher incidence of tumors among populations of certain districts where background radioactivity is elevated led to attempts to reproduce experimentally in animals a similar type of irradiation. Mice (strain 42) drank radioactive water and were subjected to weak γ irradiation. The frequency of the tumors obtained was compared with that of the control group. In all, 210 animals were used. Frequencies of from 14.7 to 27.6% of hepatomas were found in the irradiated animals compared with only a 2% incidence in the controls. The hepatoma induced in this manner appeared after irradiation over a period of 10 to 11 months, in animals whose average age was ~20 months. Histological appearance and ultrastructure of the resulting tumors are described; the livers of the animals that drank radioactive water showed significant cellular alterations; these are described. Congestive and necrotic changes accompanied the tumors and affected the livers of all the animals that drank the radioactive water. Significance of the presence within the tumor cells of tubules and granular forms, as seen by electron microscopy, and their possible relation to a virus is discussed. (BBB)

10841 FACTORS INFLUENCING HEMATOPOIETIC SPLEEN COLONY FORMATION IN IRRADIATED MICE. I. THE NORMAL PATTERN OF ENDOGENOUS COLONY FORMATION. Marsh, John C. (Yale Univ., New Haven); Boggs, Dane R.; Bishop, Carter R.; Chervenick, Paul A.; Cartwright, George E.; Wintrobe, Maxwell M. J. Exp. Med., 126: 833-49(Nov. 1, 1967).

The formation of hematopoietic colonies in the mouse spleen 10 days after irradiation was studied. Spleen uptake of Fe and iododeoxyuridine (IUdR) as well as spleen weight were measured to obtain ancillary information concerning splenic hematopoiesis. The D_0 value for Fe uptake was 50 R over the 600- to 800-R range while that for colony number was 78 R. The D_0 for IUdR uptake (193 R) was virtually identical with that for spleen weight (196 R). However, the D_0 for the latter two measurements was higher than those for the former two. These values increased with the age of the mouse. Hypertransfusion decreased spleen Fe uptake and colony number. Visible hematopoietic colonies in the spleen were not produced by vinblastine, nitrogen mustard, methotrexate, or cyclophosphamide. The results suggested that the endogenous spleen colony method measured the same parameters as does the exogenous, transplant method. Since there were reproducible interrelations between spleen colonies, spleen weight, and Fe and IUdR uptake, the erythroid composition and proliferative capacities of the colonies could be measured by the simultaneous use of both methods. (BBB)

10842 FACTORS INFLUENCING HEMATOPOIETIC SPLEEN COLONY FORMATION IN IRRADIATED MICE. II. THE EFFECT OF FOREIGN MATERIALS. Boggs, Dane R. (Rutgers Medical School, New Brunswick, N. J.); Marsh, John C.; Cher-

venick, Paul A.; Bishop, Carter R.; Cartwright, George E.; Wintrobe, Maxwell M. J. Exp. Med., 126: 851-70(Nov. 1, 1967).

The effect on hematopoietic spleen colonies by preirradiation injection of mice with various substances was examined. Injection of normal dog plasma and serum, human, rat, and Swiss–Webster mouse plasma, phytohemagglutinin, sheep erythrocytes, mumps and influenza vaccine, fibrinogen, and endotoxin before irradiation led to an increased number of endogenously derived spleen colonies in irradiated mice. Spleen weight and uptake of radioiron and iododeoxyuridine in spleen were also increased. While the number of colonies was increased, the composition of individual colonies was unchanged. In plethoric mice in which splenic erythropoiesis was abolished, increased splenic hematopoiesis was accompanied by an increase in the volume of packed red blood cells ten days after irradiation. Crude fractions of human albumin and γ-globulin, cortisol, C57BL (maternal) and DBA (paternal) mouse plasma, and isogenic plasma were without effect. It was suggested that the effect of plasma may not be due to an antigenic or an inflammatory effect. It was not known whether the increased colonies induced by plasma were representative of expansion of the colony-forming cell pool or of increased efficiency of growth of the fraction surviving irradiation. (BBB)

10843 FACTORS INFLUENCING HEMATOPOIETIC SPLEEN COLONY FORMATION IN IRRADIATED MICE. III. THE EFFECT OF REPETITIVE IRRADIATION UPON PROLIFERATIVE ABILITY OF COLONY-FORMING CELLS. Boggs, Dane R. (Rutgers Medical School, New Brunswick, N. J.); Marsh, John C.; Chervenick, Paul A.; Cartwright, George E.; Wintrobe, Maxwell M. J. Exp. Med., 126: 871-80(Nov. 1, 1967).

In mice irradiated repetitively at 6-week intervals, the proliferative capacity of the hematopoietic stem cell compartment was studied after each irradiation and compared to that of age-matched controls irradiated only once. Hematopoietic proliferation was measured by the number of spleen colonies, splenic Fe uptake, spleen weight, and volume of packed red cells ten days after irradiation. Six weeks after the first irradiation, the hematopoietic compartment was apparently supranormal in size. When such mice were again irradiated, their postirradiation hematopoiesis was greater than in controls. Thereafter, regenerative capacity fell with each irradiation. After the sixth irradiation, spleen colonies and Fe uptake were reduced to one-fifth of that of singly irradiated controls. Decline in body weight and increase in radioinduced mortality accompanied the decline in postirradiation hematopoiesis. (BBB)

10844 CLINICAL MANIFESTATIONS AND PREVENTION OF RADIATION INJURIES TO THE TEETH, MOUTH, AND JAWS. Schuele, Helmut (Univ., Erlangen, Ger.). Deut. Zahnaertzil. Z., 22: 103-26(Feb. 1967). (In German).

The pathogenesis of radiation injuries to the periodontium, the etiological significance of infections in the development of radio-osteomyelitis, effects of antibiotics on radiation-damaged bone, and healing of extraction wounds in radiation-damaged tissues were studied. In the periodontium irradiated with 4000 to 6000 R late changes observed after several yr include progressive vascular degeneration in the gingiva, increased sensitivity to irritants with gingivitis. Histologically, dystrophic changes were observed in the bony periodontium. This condition remained unchanged and clinically latent until inflammatory breakdown of the limbus alveolaris was initiated from the gingiva. The bony changes were inflammatory, not dystrophic. The marginal periodontitis was different from osteoradionecrosis. Results of radiation injuries produced during the period of teeth formation, and effects on pulp and enamel of erupted teeth after irradiation with 4000 to 6000 R are presented. Radiation injuries of the facial skin, such as pigmentation, atrophy, hyperkeratosis, ulcerations, and tumor induction are described and illustrated. Radioinduced disturbances of bone growth and radiation injuries of mature bone are outlined. Prophylactic preparation of the jaw for radiotherapy, extraction of radiation damaged tissues, therapy of osteoradionecrosis, and numerous procedures for prophylaxis and treatment of irradiation injuries are described. References cited, 171. (BBB)

10845 X RAYS IN EXPERIMENTAL EMBRYOLOGIC RESEARCH. Ritter, W.; Grueter, H. J. (Westfaelische Wilhelms-Univ., Muenster, Ger.). Deut. Zahnaertzil. Z., 22: 148-53 (Feb. 1967).

Mouse fetuses at developmental ages of 7 days and 20 hr were irradiated in utero with surface doses of 130 R. Malformations of the head region were apparent in 65% of the irradiated fetuses. There was hypoplasia of the lower mandible, with medioventral dislocation of the ears. Fused molar tissues were observed in the median level. The invagination of the tooth lamina was five times as wide as in normal animals. There was extensive invasion of the enamel pulp from ameloblasts. The results indicated certain morphodynamic factors of dental development heretofore unreported. The histological studies indicated that fusions of the teeth were predetermined. The development of foramen caecum in human teeth was interpreted from these findings as being the result of hyperplasia of the inner epithelium of the enamel. (BBB)

10846 EFFECT OF ELECTROMAGNETIC RADIATION IN THE METER RANGE IN WORKERS AT A SHORT-WAVE TRANSMITTER. Slepicka, Jií; Slivova, Anna; Pochmon, Otakar; Zapletalova, Ema (Krajske Nemocnice s Poliklinikou, Ostrava, Czech.). Prac. Lek., 19: 5-11(1967). (In Czech).

The effect of 3- to 30-Mcps radiation generated at 300 kW and of 1520-Mcps radiation at 30 kW was studied. There were 30 employees at the short wave and 19 at the medium wave transmitter who were examined. The intensity of the field in both the environments exceeded the permissible standards. In half of the workers employed in the short wave transmitter positive neurological findings were observed, especially as a neurasthenic syndrome. Most abnormalities (85%) were found by evaluation of the electroencephalographic (EEG) findings; in one-third of the cases the occurrence of hypersynchronic activity was noted. Significant deviations were observed in the glucose tolerance curve and an increase of γ-globulin was found. No relation could be demonstrated between these changes and the extent of exposure. The results indicated the hazards of short wave transmitter radiation and the hazards of medium wave radiation that were less. The necessity of introducing pre-employment and periodic EEG examinations is stressed. (BBB)

10847 MORPHOLOGICAL ABNORMALITIES RESULTING FROM RADIOFREQUENCY TREATMENT OF LARVAE OF TENEBRIO MOLITOR. Kadoum, A. M.; Ball, H. J.; Nelson, S. O. (Univ. of Nebraska, Lincoln). Ann. Entomol. Soc. Amer., 60: 889-92(Sept. 15, 1967).

Tenebrio molitor larvae were exposed to two different rf intensities at a frequency of 39 MHz. With the electrodes in contact with the top and bottom of the polystyrene holder, an electrode voltage of 3.6 KV was used for one experiment, and 0.9 KV was used for another. Adults developing from larvae exposed at sublethal levels exhibited malformed and missing legs. The number of imaginal legs was reduced as exposure time increased. The degree of leg malformation increased when treatment was administered again during the sixth instar. Similar treatments of fifth-instar larvae did not interfere with normal imaginal leg development. Deformities most likely resulted from heat damage to the histoblasts that project into the legs of the sixth or least-instar larvae. (BBB)

10848 EPIDEMIOLOGICAL STUDIES IN HUMAN RADIOBIOLOGY. Lamerton, L. F. (Inst. of Cancer Research, Sutton, Eng.); MacMahon, B. Bull. World Health Organ., 36: 475-84 (1967).

Studies relating to the detrimental effects of radiation on humans are reviewed and recommendations are made for achieving more effective epidemiological research in this field. Closer integration of laboratory investigations with epidemiological studies was stressed. (BBB) (TSS)

10849 THE ROLE OF A GERMINAL PLASM IN THE FORMATION OF PRIMORDIAL GERM CELLS IN RANA PIPIENS. Smith, L. Dennis (Argonne National Lab., Ill.). Develop. Biol., 14: 330-47(Oct. 1966).

Ultraviolet irradiation of the vegetal hemisphere of frog eggs, beginning at the first cleavage division, with doses greater than 8000 erg/mm^2 resulted in complete elimination of primordial germ cells in 100% of the larvae that were otherwise apparently normal. Irradiation of the animal hemisphere with equivalent doses of uv had no apparent effect on the formation of primordial germ cells. The effect of uv on germ cell formation was greatest at the time of the first division. Then, increasingly fewer eggs, irradiated at the vegetal hemisphere, developed into larvae without germ cells. At the eight cell stage, complete elimination of germ cells was not observed. Restitution of the germ line in irradiated eggs was obtained by injecting vegetal hemisphere cytoplasm from unirradiated eggs into the vegetal hemisphere of irradiated eggs, but restitution did not occur by injection of animal hemisphere cytoplasm. The uv action spectrum of germ cell inactivation suggested that the sensitive material is a nucleic acid. A specific cytoplasmic germinal determinant is postulated which is present only in the vegetal hemisphere cytoplasm. It is probably a nucleic acid, and appears in embryonic development prior to the first cleavage division. (BBB)

10850 DELAYED RADIATION LESIONS OF THE HUMAN SPINAL CORD: REPORT OF FIVE CASES. Kristensson, Krister; Molin, Bjoern; Sourander, Patrick (Univ. of Goteborg). Acta Neuropathol., 9: 34-44(Aug. 2, 1967).

Case reports on radioinduced injuries are given for five adult patients with carcinoma of the hypopharynx treated by x irradia-

tion or by a combination of x and teleradium irradiation. The x rays were given at 170 to 195 KV with a fractionated radiation technique during the period 1936 to 1949. In general, three fields of radiation were used, one from each side and one from the back. In case 1 treatment over an additional anterior field was given and in case 4, nine different fields were used. In cases 2 and 3 teleradium was given as a supplementary treatment just after the conclusion of the x-ray treatment. In case 1, the cervical cord segments C_3-C_8 showed widespread involvement. Myelin sheaths and axons were disintegrated in both posterior columns. Changes of the blood vessels occurred mainly in and around these areas. The walls of the capillaries, arterioles, and smaller arteries were thickened by a fibrous hyaline material and their lumina were constricted. No fibrinoid necrosis of the vessel walls or thrombosis were noted. Fibrillary astrocytosis occurred subpially and in the grey matter. In case 2, in segments C_5-C_8 myelin sheaths and axons were destroyed in an area corresponding to both posterior columns, where abundant subanophilic material and fibrillary astrocytosis were found. Changes of the vessels were as described in the previous case. In case 3, in addition to localized necrosis with cavitation, marked astrocytosis was found. Changes of the vessels were as described above, including telangiectasis. There was a slight infiltration of lymphocytes around the vessels, especially in the meninges. Many vacuolated nerve cells were seen. Both cases 4 and 5 revealed destruction of the myelin sheaths and axons with cavitations. Changes of the vessels as described in the foregoing cases occurred, and small hemorrhages around telangiectatic vessels were found. Telangiectases were found in all cases. The pathogenesis of the damage is discussed in relation to experimental postirradiation lesions of the central nervous system. The vascular lesion was considered to be the most important pathogenetic factor. (BBB)

10851 LETHAL RADIATION IN ANIMALS. Fine, Jacob; Rosoff, Chester. J. Amer. Med. Ass., 202: 152(Oct. 9, 1967).

The mortality of rats exposed to whole-body radiation in the midlethal range (550 RAD), that was nearly 100%, could be reduced to near zero if the intestinal coliform flora was suppressed by an orally administered nonabsorbable antibiotic. The protection was maximal if it was started shortly before irradiation or immediately afterward. For full recovery from the injury, the antibiotic was needed up to 21 days after exposure. This protection was lost if bacterial endotoxin was fed to such animals. Therefore, bacteria or their products absorbed from the intestine appear to be a major factor in the death caused by irradiation in the midlethal range. The endotoxin-detoxifying system, which is principally located in the reticuloendothelial system of liver and spleen, is one of the functions injured by radiation. Since its potential returns to normal after three weeks, the dose of radiation delivered is not sufficient to totally destroy this system. The diarrhea, leukopenia, anemia, and invasive sepsis that are manifestations of the degree of radiation injury are the consequences of damage to the antibacterial defense mechanisms because they are prevented or minimized when the coliform flora is suppressed. (BBB)

10852 URETERAL OBSTRUCTION DUE TO RADIATION. Graham, John B.; Abad, Rainerio S. (Roswell Park Memorial Inst., Buffalo). Amer. J. Obstet. Gynecol., 99: 409-12(Oct. 1, 1967).

A study of patients receiving radiotherapy for cancer of the cervix revealed frequent ureteral obstruction, as indicated by intravenous pyelograms. The most common cause of death in cervical cancer is uremia due to ureteral obstruction; 37% of patients coming to autopsy died of this cause. Cancer is the common cause of ureteral obstruction in the patient with cervical cancer who was treated with radiation, but radiation damage can result in ureteral obstruction and uretero-vaginal fistula. Salpingitis is a predisposing factor. Acute infection during radiotherapy should be recognized in the closely followed patient and treated with bilateral salpingo-oophorectomy. Late ureteral obstruction is insidious for it rarely produces symptoms until severe renal damage has been inflicted. Routine pretreatment intravenous pyelogram, a high level of suspicion, and posttreatment intravenous pyelograms in patients with renal impairment or infection are the best means of recognizing this complication. Moderate or severe obstruction requires a laparotomy and relief of the obstruction. (BBB)

10853 INFLUENCE OF COMPLEX COMPOUNDS OF TRACE ELEMENTS ON THE RATE OF INCORPORATION OF ^{14}C-GLYCINE INTO γ-GLOBULIN AND ANTIBODIES OF NONIRRADIATED AND IRRADIATED RATS. Nikolaev, A. I.; Khalifaev, S. M.; Mukhammadzhanov, Kh. R. (Scientific Research Inst. of Roentgenology, Radiology, and Oncology, Tashkent, Scientific Research Inst. of Vaccines and Sera, Tashkent). Radiobiologiya, 6: 802-3 (1966). (In Russian).

The effects of vitamin B_{12}, cobalt-30 (complex compound of cobalt chloride and methionine), copper glutamide (complex compound of copper and nicotinamide), and feramide II (complex compound of ferric sulfide with nicotinamide) on the rate of incorporation of ^{14}C-labeled-glycine into nonspecific γ-globulin and serum anitbodies and on the precipitation titer of γ-irradiated rats were investigated. Cobalt-30, copper glutamide, and feramide II stimulated the incorporation of ^{14}C-glycine into the nonspecific γ-globulin and serum antibodies of nonirradiated rats; this was accompanied by an increase in the precipitation titer. With the exception of vitamin B_{12}, all of the compounds stimulated the incorporation of ^{14}C-glycine into the nonspecific γ-globulin and antibodies of rats immunized two days prior to irradiation. (TSS)

10854 CHROMOSOMES AND CELLULAR RADIOSENSITIVITY. I. RELATIONSHIP OF D_0 TO CHROMOSOME VOLUME AND COMPLEXITY IN SEVENTY-NINE DIFFERENT ORGANISMS. Sparrow, A. H.; Underbrink, A. G.; Sparrow, Rhoda C. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Radiat. Res., 32: 915-45(1967). (BNL-10981).

Cellular radiosensitivity (D_0) was correlated with the chromosome volume of seventy-nine organisms ranging from viruses to higher plants and animals. A plot of D_0 versus interphase chromosome volume resulted in a series of eight regression lines whose slopes did not differ significantly from −1. For organisms within each regression group (radiotaxon), D_0 was inversely related to average chromosome volume. The constants indicated by each of the −1 slopes were expressed in terms of amounts of energy (eV) absorbed at D_0 by the average chromosome of each species, and this amount of energy was nearly constant for organisms in each radiotaxon. Organisms in radiotaxon I absorbed approximately 200 eV per chromosome at D_0, while those in radiotaxon VIII absorbed more than 16,000 times as much. The organisms in these radiotaxa did not show any consistent relation with respect to classical taxonomy, genetic complexity, or level of ploidy. These radiotaxa are probably a reflection of other chromosomal parameters, both structural and physiological, the sums of which result in a specific level of energy absorption at D_0. It was concluded that the size of the chromosome is a highly significant index of cellular radiosensitivity but that survival response is also influenced by other variables. (175 references) (auth)

10855 STUDIES ON THE PRODUCTION OF BLACK PEARLS BY IRRADIATION WITH RADIOACTIVE RAYS. III. RELATIONSHIP BETWEEN THE COLORATION OBTAINED BY γ-RAY IRRADIATION AND THE MANGANESE CONTENTS IN THE SHELLS OF SEVERAL SHELLFISHES. Horiguchi, Yoshishige; Tsujii, Tadashi (Prefectural Univ. of Mie, Tsu, Japan). Nippon Suisan Gakkaish, 33: 5-11(Jan. 1967).

The possibility of producing black pearls by γ irradiation was investigated. The shells of 9 species of fresh-water shellfishes with various contents of manganese were irradiated with γ rays. The effects of the manganese contents and amounts of released iodine on coloration in their shells are discussed. Coloration of the shells of fresh-water and marine shellfishes by γ irradiation was found to be proportional to their manganese contents and to amounts of released iodine. A few shells gave conflicting results. The shell of Corbicula sandai Reinhardt was the only one having a small amount of manganese that was hardly colored by γ irradiation. The colored material which was produced in the shell irradiated with γ rays was stable for 16 months or more at room temperature, but was comparatively unstable and discolorable in high temperature over 50°C. (auth)

10856 STUDIES ON THE PRODUCTION OF BLACK PEARLS BY IRRADIATION WITH RADIOACTIVE RAYS. II. ON THE FORMATION OF MANGANESE-RICH MARINE PEARLS IN PEARL OYSTERS. Tsujii, Tadashi; Horiguchi, Yoshishige (Prefectural Univ. of Mie, Tsu, Japan). Nippon Suisan Gakkaish, 32: 917-21(Nov. 1966).

The formation of marine pearls containing rich amounts of manganese and the relation between the degrees of coloration of γ irradiated pearl layers and their manganese contents were investigated. By the injection of manganous carbonate paste, at a ratio of about 50 mg anhydrous matter per shellfish, the manganese contents in the pearl layers of pearl oysters rose to about 300 γ per g (about 3 γ manganese deposited per pearl of about 4.5 mm in diameter) during 13 days. When manganous carbonate-peanut oil paste was used, the manganese contents rose to about 40 to 67 γ per g (1.76 γ per pearl). It was concluded that the degrees of coloration of the pearl layer caused by irradiation at a dose of 2×10^7 R for the marine pearl layers containing various contents of manganese are proportional to their manganese contents. (auth)

10857 ON THE FORMATION OF VISCERAL INVERSION CAUSED BY RADIOACTIVE IRON AND CALCIUM. Nishimura, Kenji (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 16: 253-62(Jan. 1967).

Invaginated gastrulae of Bufo vulgaris formosus at an early stage were placed in aqueous solutions of $^{59}FeCl_3$ for 23 days, some in 4 μCi/l and the others in 8 μCi/l. Gastrulae at the intermediate stage were kept for nine days in 12, 30, 60, 150, or 300 μCi/l solutions. In addition, other gastrulae in the intermediate stage were kept for nine days in 120, 300, 600, 1500, or 3000 μCi/l $^{45}CaCl_2$ solutions. In control experiments, nonradioactive $FeCl_3$ and $CaCl_2$ solutions or tap water were used. When exposed to strong irradiation (60 to 300 μCi/l solutions of $^{59}FeCl_3$ and 1500 to 3000 μCi/l solutions of $^{45}CaCl_2$) all the eggs died within the experimental period. Mortality of these embryos was in proportion to the intensity of irradiation; some individuals developed abnormalities. No particular difference was recognized between the type of deformities produced by ^{45}Ca or ^{59}Fe. Among the chief internal deformities observed were impeded organ development, dislocation or inversion of the heart and of the viscera in the abdomen. Seven cardiac inversions and eight visceral inversions out of a total of 88 surviving embryos were seen. In one embryo, exposed to radiation from 4-μCi/l ^{59}Fe solution, the auricle was considered to have been converted into a ventricle, and in another, laminated tissue resembling the internal gill wall migrated into the intestinal wall. Another embryo in which the notochord and spinal cord were separated was seen. (BBB)

10858 APPLICATION OF PREMACK'S THEORY TO A CLASSICALLY CONDITIONED SUCROSE AVERSION INDUCED BY X-RAY EXPOSURE. Schaeffer, Robert W. (Florida State Univ., Tallahassee); Hunt, Edward L.; Kimeldorf, Donald J. Psychol. Rec., 17: 359-67(July 1967).

Six-months-old Sprague–Dawley rats were tested daily for 60 days on a two-bottle 30-min preference test in which one bottle contained water and the second bottle contained either water or a 4, 8, 16, or 32% sucrose solution. A classically conditioned aversion was induced by pairing the taste of sucrose with an exposure to 100 R of x rays (5 R/min) on three successive occasions. The rate of sucrose drinking prior to and following each irradiation, as well as the degree of the conditioned aversion, varied directly with the concentration of the sucrose solution. This was interpreted as evidence for the applicability to classical conditioning of Premack's reinforcement theory in which the rate of reinforced responding is determined in part by the precontingency rate of the response. The physiological alterations made in response to the unconditioned stimulus, ionizing radiation, were not identified. The fact that water intake for the group that was tested daily with water present in both bottles was not systematically altered by irradiation suggested that the aversion to sucrose could not be explained on the basis of an aversion to drinking or to alterations in thirst. When the developmental time course of radioinduced saccharin aversion was examined in animals that were irradiated and then given an immediate 24-hr preference test between saccharin and water, they preferred saccharin for about 30 min; thereafter, they avoided the saccharin and drank only water. Results were interpreted in support of the humoral theory of the radioinduced aversion phenomenon. (BBB)

10859 TREATMENT OF POLYCYTHEMIA VERA. Hennemann, H. H.; Stecher, G. (Univ., Heidelberg). Deut. Med. Wochenschr., 92: 1874-6(Oct. 13, 1967). (In German).

The principles of treatment of polycythemia vera include reduction of excess cells by venous removal and prevention of abnormally increased cell production by treatment with ^{32}P. Use of ^{32}P involves hazards such as irradiation of bone marrow to produce thrombopenia or leukopenia or transition of the disorder into acute leukemia. Although the increase in acute leukemia incidence in ^{32}P-treated patients was confirmed statistically, this increased leukemia risk appears to depend not on the duration of the disease, but upon the total dose of ^{32}P administered. Polycythemia is a disease that has a predilection to change to leukemia that is promoted or accelerated by ^{32}P administration. (BBB)

10860 STUDIES ON THE ERADICATION OF ANOPHELES PHAROENSIS THEOBALD BY THE STERILE-MALE TECHNIQUE USING ^{60}Co. VI. SPERM ACTIVITY IN MALES IRRADIATED WITH THE STERILIZING DOSE. Abdel-Malek, A. A.; Tantawy, A. O.; Wakid, A. M. (Middle Eastern Regional Radioisotope Center for the Arab Countries, Cairo). J. Econ. Entomol., 60: 1300-2(Oct. 1967).

Matings between nonirradiated female mosquitos and either normal or irradiated males (12,000 R) were carried out in breeding cages to investigate the activity of sperm from γ irradiated males. Normal or irradiated males, after complete matings with females, were replaced by irradiated or normal males, and egg production and hatchability were recorded daily for the first ten days. Replacement of normal males with irradiated males caused a decrease in egg hatchability when compared with the controls, but insemination by normal males did not nullify insemination by irradiated males. Sterilization of males with 12,000 R did not damage the sperm; the sperm of irradiated males competed successfully with that from normal males, whether it was present in the spermatheca before or after copulation with normal males. Delaying the mating of males for five days after irradiation did not restore viability of the sperm. (BBB)

10861 INTERACTION OF ENCEPHALOMYOCARDITIS VIRUS WITH ULTRAVIOLET-IRRADIATED HOST CELLS. Balduzzi, P. C. (Univ. of Rochester, N. Y.). J. Virol., 1: 509-13(June 1967).

Ultraviolet irradiation impaired the capacity of L cells to support growth of encephalomyocarditis virus. The loss of capacity was partially restored by high multiplicity of infection (MOI). This phenomenon was not due to an increased probability of an infectious virus particle reaching a site of replication undamaged by uv, since uv-inactivated virus at high MOI induced restoration of the capacity to support multiplication of nonirradiated virus adsorbed at low MOI. Multiplicity reactivation of uv-irradiated virus did not play a role in this phenomenon since restoration of capacity took place without multiplication of the uv-irradiated restoring virus. The evidence indicates that restoration of capacity was not due to viral interactions involving genetic exchange. The ability to restore capacity was a property more radioresistant than infectivity, suggesting that the former is a function of only part of the viral genome. (BBB)

10862 FEARFULNESS IN THE CONTROL AND IRRADIATED RAT. McDowell, A. A.; Merchent, G. M. (Texas A and M Univ., College Station). J. Genet. Psychol., 111: 69-72(Sept. 1967).

Earlier results indicated greater fearfulness in fetally and neonatally irradiated rats than in control rats, in tests that included tilting cages, an open field, and home-cage emergence. An open field with a darkened tunnel leading from one side was used. Both time to emerge from the darkened tunnel to the open field and time to escape from the open field into the darkened tunnel were used as measures of fearfulness. Adult rats were whole-body γ-irradiated at 500 R doses in 50 sec. Each rat was placed in the darkened tunnel on days 7, 14, and 21 postexposure, and the time to emerge to the open field was recorded. A maximum of 5 min was allowed. On day 28, each rat was placed in a corner of the open field opposite the tunnel and the time to enter the tunnel was recorded. Again, a maximum of 5 min was allowed. None of the rats in either control or irradiated group emerged during the maximum time limit of 5 min. The mean entrance time for the control groups on day 28 was less than one-half the time taken by the irradiated rats to escape from the open field. The difference between the escape times of the two groups was beyond the 0.02 significance level as measured by the one-way analysis of variance by ranks. These data failed to show any difference between control and adult irradiated rats with respect to entrance to an open field from a darkened runway; however, control rats were much faster in escaping from an open field than irradiated rats. This confirmed the greater fearfulness for the control rats than for irradiated rats. This interpretation is in direct contrast to that of an earlier study, and possibly reflected, more than anything, the difference in age of the rats at the time of exposure. (BBB)

10863 RADIATION-INDUCED MALIGNANCY IN A PATIENT WITH ACNE VULGARIS: REPORT OF FOUR DIFFERENT HISTOLOGIC TYPES. Bingham, Hal G. (Univ. of Missouri, Columbia); Robinson, David W. Amer. J. Surg., 114: 472-6 (Sept. 1967).

The finding of 56 lesions caused by radiotherapy of benign conditions is reported. The case history is given of a female patient who developed multiple malignant lesions in the skin of her face and nose after receiving x-ray therapy over a two-year period for acne vulgaris. The etiology of the four different types of malignant lesions, which included typical basal and squamous cell carcinomas, fibrosarcoma, and localized lymphocytic lymphoma, is presented. Adenosarcoma of the breast was also observed. Surgical methods used to remove the neoplasms and to correct the resulting defects are described. (BBB) (TSS)

10864 SUSCEPTIBILITY OF VARIOUS STAGES OF DROSOPHILA MELANOGASTER TO GAMMA RADIATION. Henneberry, T. J. (Dept. of Agriculture, Beltsville, Md.). J. Econ. Entomol., 60: 1041-3(Aug. 1967).

The metamorphic stages of Drosophila melanogaster were exposed to γ radiation from a ^{60}Co source. The sensitivity, in de-

scending order, was: eggs, 1-day-old larvae, 1-day-old pupae, 3-day-old larvae, 3-day-old pupae, and adults. Exposure of eggs to 0.9 KR or more caused a high mortality rate in the egg and larval stages after exposure to 0.4 to 0.6 KR; death occurred in the pupal stage. The 4- to 6-hr-old egg stage was the most sensitive to radiation. One-day-old larvae were more susceptible to irradiation than 3-day-old larvae and about as susceptible as 1-day-old pupae. Three-day-old pupae were 20 times as resistant to the lethal effects of radiation as 1-day-old larvae or pupae, 15 times as resistant as 3-day-old larvae, and 80 times as resistant as 4- to 6-hr-old eggs. When larvae were irradiated, nearly all deaths occurred in the pupal stage; large doses prevented adult emergence. Female longevity was not significantly affected by exposure of adults to as much as 35 KR; females were more resistant than males. Males exposed to 21 KR were shorter lived than untreated males, and longevity decreased with increasing exposure to 35 KR. (BBB)

10865 GROSS MANIFESTATIONS OF CONTINUOUS GAMMA IRRADIATION ON THE PRENATAL RAT. Coppenger, Claude J.; Brown, Sidney O. (Texas A and M Univ., College Station). Radiat. Res., 31: 230-42(June 1967).

To determine the effects of continuous, low-intensity γ-irradiation on the developing rat, impregnated females were subjected to γ-radiation at 50 R per 20-hour day, beginning on the first day of pregnancy. Prenatal effects were determined by examination of the embryos, fetuses, and uteri on specific days 10 through 20 of gestation. Irradiation at this level did not affect the total number of implantations, but a great increase in mortality was observed at the twelfth day. Most radiation-induced deaths and resorptions occurred prior to the fifteenth prenatal day. As measured by increase in weight and length, the prenatal growth of the irradiated embryo and fetus was greatly retarded. Gross abnormalities in the irradiated late fetus were a reduction in body size, microencephaly, and reduction of spleen weight. Other less generalized abnormalities are described that include anophthalmia, sternal malformations, and edema. (auth)

10866 ^{90}Sr-^{90}Y EXTRACORPOREAL IRRADIATION IN GOATS AND MAN. Winkelstein, Alan; Craddock, Charles G.; Martin, Donald C.; Libby, Raymond L.; Norman, Amos; Sasaki, Masao S. (Univ. of California, Los Angeles. Wadsworth Hospital, Los Angeles). Radiat. Res., 31: 215-29(June 1967).

Studies on the efficacy of low (25 rads/transit) transit dose extracorporeal irradiation (ECI), using a $^{90}Sr-^{90}Y$ β-emitting source, were undertaken in a series of 10 goats and three uremic patients. In animal studies, lymphopenia could be regularly produced after 20 to 30 hours of intermittent irradiation. The histologic assessment of lymphocyte depletion was quite variable. In goats weighing more than 30 kg. the total lymphocyte mass was not measurably depleted, but in smaller animals there was striking depletion of lymphocytes from the mantel zones of lymphoid follicles and a selective preservation of germinal center cells. Two uremic patients were extensively irradiated prior to renal transplantation, but they did not show measurable lymphocyte depletion in lymph node biopsy, and the interval between transplantation and graft rejection was not prolonged. Measurements of radiation-induced chromosomal changes in lymphocytes, in all three irradiated patients, provided significant data in delineating limitations of this technique. Low transit dose ECI does not appear suitable as a means of producing significant lymphocyte depletion in man, probably because the dose is insufficient to lethally irradiate lymphocytes during a single transit through the irradiator. (auth)

10867 ON SOME PATHOMORPHOLOGICAL FINDINGS IN THE CASE OF ACUTE RADIATION EFFECTS IN GOATS. Otoupal, P.; Pawel, O.; Dvorak, E. Vet. Med. (Prague), 12: 427-34 (Aug. 1967). (In Czech).

Eleven goats from two to seven years of age were dissected and examined histologically. Of these, five animals were irradiated with doses of 1200 or 1600 R. Six goats were irradiated with a dose of 700 R, and they died or were killed between the 10th and 30th days after exposure. Irradiation was applied from a ^{60}Co source at a rate of 140 R per hour. The dissection finding was characterized by a well developed hemorrhagic diathesis with localization on serosas particularly in the thoracic cavity, especially in animals dissected after the eighth day postirradiation. Hemorrhages were found in physiologically strained muscles, in intercostal muscles, in the diaphragm, and in the myocardium. No regressive changes in the form of ulcers in the digestive organs were found. Necrobiotic deposits in the livers were found already macroscopically, and aggregations of bacteria were determined histologically in the centers of these deposits. A beginning of the regeneration of lymphoid tissue in the lymphatic nodes of goats that were irradiated with a dose of 700 R was ascertained on the 10th day after exposure. In the adrenal cortex dystrophic changes in the epithelium of the efferent canals with an edema were observed and a falling out of proteinic substances into Bowman's capsule. Some observations were attributed to the species of the experimental animal, in particular, the total intensity, extent, and localization of hemorrhages in the skin and muscles, and localization of regressive and necrobiotic changes in intestinal mucous membranes and in the liver. (auth)

10868 EFFECTS OF SINGLE, CONTINUOUS, AND FRACTIONATED GAMMA IRRADIATION ON SEMEN QUALITY IN ALBINO RATS. Lawson, Rommon L.; Krise, G. M.; Brown, S. O.; Sorensen, A. M. Jr. (Texas A and M Univ., College Station). Radiat. Res., 31: 273-86(June 1967).

Groups of Holtzman strain albino rats, from which the coagulating glands were surgically removed, were exposed to either acute whole-body irradiation of 47, 80, or 133 R, continuous whole-body irradiation of 5, 10, or 20 R per 23-hour day, or fractionated continuous whole-body irradiation of 10 to 20 R per 23-hour day for one week followed by one week of no irradiation. Continuous and fractionated continuous exposures extended over a period of 15 weeks. Semen acquired by electroejaculation was evaluated for packed sperm volume, total sperm count per ejaculate, percentage of motility, and percentage of abnormal sperm. Animals subjected to acute radiation responded with lowered packed sperm volume, concentration, and motility, and increased abnormalities, followed by apparent recovery by 48 days. This suggests a time of spermatogenesis of 49 days in the animals used. The maturation process and the maintenance of mature sperm were evidently interrupted. Continuous and fractionated irradiated animals responded similarly to dose levels of 10 and 20 R with decreased packed sperm volume, concentration, and motility, and increased percentage of abnormalities at approximately 11 weeks from the first exposure. Dose levels of 5 R gave an intermediate response between the controls and 10 R levels. It was interesting to note that an accumulated exposure of 385 R for the 10 R fractionated group gave a response similar to that caused by 20 R of continuous exposure for a total exposure of 1540 R over an 11 week period. (auth)

10869 BIRTH WEIGHT IN PIGS DESCENDED FROM IRRADIATED SPERMATOGONIA. Cox, D. F. (Ames Lab., Iowa). Contract AT(11-1)-707. Mutat. Res., 4: 865-9(Nov.-Dec. 1967).

Birth weights of individuals descending from irradiated spermatogonia were studied in two breeds of domestic pigs. The data included measurements on 30965 pigs born between 1960 and 1966 on a single farm. The average birth weight was 1.3 kg. The weights were adjusted for season of birth, litter size, parity and sex, and the adjusted weights were analyzed for the effect of paternal exposure to 300 R x radiation. Pigs from irradiated sires were 0.003 kg lighter than the contemporary controls, a difference of approximately half of the standard error and representing only 0.2% of the total variance. The absence of any important changes in the average birth weight ascribable to radiation was accompanied by a lack of detectable differences in the range or variance. Genetic control of the birth weight was evidenced by distinct breed differences, but no additive genetic variance was detected within the breeds. A correlation of +0.3 among the birth weights of litter mates was probably the result of common uterine environment, with possible contributions from nonadditive genetic variance. The mutations induced in the spermatogonia by the radiation treatment either had no influence on birth weight or were largely recessive. (auth)

10870 EFFECT OF IONIZING RADIATION ON THE OVARIES OF JAPANESE MEDAKA, ORYZIAS LATIPES (T. et S.). Srivastava, P. N. (Univ. of Rajasthan, Jaipur, India). Acta Anat., 63: 434-44(1966).

Fish were irradiated with 32,000 R doses of x rays (LD_{50} reached within 4 to 5 days). The youngest and completely mature oocytes were very radiosensitive and were destroyed soon after irradiation with 32,000 R. In younger oocytes, the nuclei became pyknotic. Nucleoli were also radiosensitive; they were reduced in number and became swollen and vacuolated. Two days after irradiation, some nuclei showed chromatolysis, and the follicular epithelium hypertrophied. Four days after irradiation, all the oocytes seemed to be abnormal and degenerating. A few larger oocytes appeared to be normal. By six days after irradiation, the ovarian tissue completely degenerated. The mean weight of the ovaries declined from 70.0 to 22.9 mg 6 days after irradiation. Immediately after irradiation the number of eggs laid declined greatly. The ratio of viable to nonviable eggs was 1.1 : 1.3 on the first day, 1.0 : 2.5 on the second day, 7.1 : 2.4 on the third day, 11.1 : 2.1 on the fourth day, 8.5 : 3.0 on the fifth day, and 1.5 : 1.0 on the sixth day. In the irradiated ovary there was a significant increase in the number

of atretic follicles. The follicular epithelium showed typical hyaline degeneration after irradiation. (BBB)

10871 BASOPHIL ADENOMATA IN THE PITUITARY GLANDS OF 2-YEAR-OLD MALE LONG–EVANS RATS. Griesbach, W. E. (Univ. of Otago Medical School, Dunedin, N. Z.). Cancer Res., 27: 1813-18(Oct. 1967).

Pituitaries of male and female Long–Evans rats were examined two years after internal or external thyroid radiation. Treatment with radioiodine significantly increased the numbers of thyrotropic pituitary cell adenomata in both sexes. No increase in the numbers of such adenomata followed the x irradiation of the male thyroid glands in the doses used. Gonadotropic cell adenomata were found in 74% of male rat pituitaries. The incidence was not affected by thyroid irradiation. In the female rat pituitaries, the incidence of gonadotropic cell adenomata was only 3%. On the basis of cytoplasmic granule characteristics, most of the gonadotropic cell adenomata could be homologized with follicle-stimulating hormone cells or with luteinizing hormone cells. (auth)

10872 SURVEY ON CARCINOGENESIS INDUCED BY MEDICAL RADIATION. Okazima, Shunzo (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 40: 652-61(Aug. 1965). (In Japanese).

The history of irradiation of the 8923 cancer and 11,556 noncancer patients in university hospitals of Japan was surveyed. The frequency of irradiation (both in treatment and in x-ray diagnosis) in cancer cases was about the same as that in the noncancer cases. However, in radiation-treated patients the incidence of tumors (0.94%) was significantly higher than in untreated controls (0.61%). The occurrence of thyroid cancer and of skin cancer in the neck region was correlated with the earlier radiation treatments. In 147 Thorotrast-treated patients, the incidence of liver cancer was higher than in the control group. There was no significant difference in sex ratio and age in the incidence of cancer. The incidence of various cancers in irradiated patients was: cancers of the thyroid 4.54%, neck 1.21%, stomach 0.05%, uterus 0.17%, ovary 1.04%, urinary bladder 0.63%, skin 4.55%, malignant lymphatic tumors 2.24%, and leukemia 1.42%. The control group showed a mean tumor rate of only 0.61%. For skin, neck, and thyroid cancers there was a linear correlation between radiation dose and the increase in incidence. A similar correlation between Thorotrast administration and carcinogenesis was also demonstrated. (BBB)

10873 COMPLICATIONS OF EXTRAPERITONEAL SURGICAL IRRADIATION AT HIROSAKI. REPORT 2. PARESIS-LIKE SYMPTOMS AND PAINS OF THE LEGS. Onodera, Norihiko (Hirosaki Univ., Japan). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 14: 46(Jan. 1967).

In the clinical experience in the use of extraperitoneal surgical irradiation at Hirosaki Univ., paresis-like symptoms or pains in the legs were frequently noted in association with cysts of the extraperitoneal dead space. Such complications were found in 23 of 65 patients (35%). The etiology of these complications has not been solved. Paresis-like symptoms were usually combined with functional disturbances of the lower extremities; i.e., difficulties in sitting down and standing up promptly or in climbing stairs. On the other hand, pains of the legs were usually not diffuse but localized in certain areas innervated by such nerves as the fibularis and tibialis. These disturbances were noted on the average at the 24th day: in 14 of 23 cases (60%) within 10 days, 16 cases (70%) within 30 days, and the remaining 7 cases (30%) later than 30 days. The incidence of these disturbances on the left side was higher than on the right side. Improvement was noted in 14 of 23 cases (60%) within 3 months; however, there were 6 cases (26%) where the symptoms lasted more than 6 months. No close correlation was found between the dose of γ rays delivered by interstitial radiation and the incidence of these complications. In some cases in which interstitial radiation was carried out only in one side, symptoms occurred only on the contralateral side. (BBB)

10874 RADIATION SICKNESS AFTER THERAPEUTIC ADMINISTRATION OF 806 mCi OF ^{131}I FOR THYROID CANCER. Silink, K.; Nemec, J.; Kubal, J.; Rohling, S.; Vohnout, S. (Research Inst. of Endocrinology, Prague). Nucl.-Med., 6: 170-83(July 15, 1967).

The clinical course and the hematologic events in a patient suffering from metastatic thyroid cancer after administration of 806 mCi of ^{131}I are described. A serious bone marrow depression developed and was treated successfully. The hematological changes during the early and late phases of the radiation injury were studied in detail and compared with those after external irradiation. The hematological events after internal irradiation with ^{131}I are characterized by initial neutrophilic leukocytosis, protracted lymphopenia, slowly developing anemia reaching lowest values about three months after administration, erythroid hyperplasia in the bone marrow after recovery from bone marrow depression and prominent cytological features of the bone marrow, especially pronounced erythropoietic polyploidy. (auth)

10875 INFLUENCE OF ^{137}Cs AND ^{90}Sr ON THE GROWTH OF EARLY STAGE AMPHIBIAN EGGS. Nishimura, Kenji (Mie Prefectural Univ., Tsu, Japan). Mie Med. J., 16: 245-51 (Jan. 1967).

Eggs of Bufo vulgaris formosus were collected 3 hr after artificial insemination, 2-cell stage, and treated with various amounts of ^{90}Sr and ^{137}Cs. In solutions of 0.05, 0.01, and 0.001 mCi/l they showed nearly the same degree of development and growth as the control groups. However, several exogastrula forms were produced in each of the groups treated with ^{90}Sr. Those which were treated with ^{137}Cs solutions of higher activities, namely 1 or 0.2 mCi/l, developed and grew at almost the same rate as the controls. A more noticeable effect of radioactivity was seen in those treated with a solution of ^{90}Sr (0.2 mCi/l) or ^{137}Cs (5 mCi/l). Delayed invagination of gastrulae or failure to complete invagination was seen but the survival rate was relatively high. The strongest influence was exerted by ^{90}Sr solutions of 1 and 5 mCi/l; the individuals grew to be blastulae only when those of the control group had grown to be neurulae (on the 6th day). All eggs treated with 5 mCi/l died before gastrular invagination occurred. Some individuals treated with 1 mCi/l grew tail buds after the neurular stage, but others remained gastrulae. On the 16th day controls grew to be 10 mm long but the surviving embryos (50%) of those treated with the ^{90}Sr solution of 1 mCi/l remained 6.5 to 7 mm in body length. On the 19th day most treated embryos underwent clasmatosis beginning with the ventral side and their yolks were exposed. Four-cell embryos treated with ^{90}Sr or ^{137}Cs solutions of 0.05 and 0.001 mCi/l and with ^{137}Cs solutions of 1 and 0.2 mCi/l showed about the same degree of development as controls, but those treated with ^{90}Sr at 0.2 mCi/l showed delayed formation of neural plates. As a result, they were a little smaller than the controls in the tail bud stage, but at the 21st day they showed almost no difference from control individuals. (BBB)

10876 ARTHROPATHIES AFTER IRRADIATION. Kolar, Jaromir; Vrabec, Radko; Chyba, Jiri (Charles Univ., Prague). J. Bone Joint Surg., 49A: 1157-66(Sept. 1967).

Systemic observations were made on radioinduced bone changes in 458 patients who underwent radiotherapy and in persons with radiation damage to the skin of their hands sustained occupationally. Over a 10-yr period, 36 patients with joint damage among the 458 patients who received therapeutic irradiation and 18 patients from the other group were noted. Three types of arthropathy were caused by irradiation: degenerative arthropathy, slowly progressive arthritis, and ankylosing arthritis. Degenerative arthropathies were most common. Their most impressive forms were seen roentgenographically in the knee or hip. X irradiation, at 140 to 200 KV, was given for various extraskeletal tumors with a depth dose to the joint of 2800 R or more. The roentgenographically observed course was similar to the course of other types of degenerative arthritis, but once symptoms developed its progress was more rapid. In patients with spontaneous fractures of the irradiated femoral neck, arthritis became evident within several years after irradiation. In patients without fractures, an average of nine years elapsed after the radiotherapy. All patients had considerable radioinduced changes in the skin overlying the joint involved. The sequelae of irradiation in bone and cartilage were similar; in both there were regressive and necrotic changes. In the cartilage, considerable loss of mucopolysaccharides from the intercellular matrix was evident and the remaining polysaccharides were irregularly dispersed. Further evidence of degenerative changes in cartilage in man after irradiation was seen in the degenerative spondylopathy in patients irradiated over the spine. Eight cases of this spondylosis and osteochondrosis were noted; the area of the spine affected had been irradiated for syringomyelia or hemangiomas of the vertebrae when the patients were young adults. The basic microscopic findings of inflammatory arthritis in irradiated patients were the same as degenerative arthropathy, with a superimposed inflammatory reaction and destruction of the joint. When healing occurred spontaneously, this kind of arthritis ultimately led to ankylosis. Based on the various radioinduced bone changes in the patients studied, a sequence of joint changes was delineated, ranging from simple, but accelerated, degenerative arthropathy to arthritis and ankylosis. The evidence that radiation induced the changes is discussed. (BBB)

10877 ANALYSIS OF THE EFFECTS OF NEUTRON RADIATION ON DEVELOPING TRITURUS EMBRYOS. Suzuki, Akio (Kumamoto Univ., Japan). J. Exp. Zool., 165: 111-16(June 1967).

Triturus pyrrhogaster embryos at various stages of development (four to eight cells, midblastula, early gastrula, early neurula, and tail-bud stages) were exposed to neutron radiation for 20 or 30

min (Cockcroft-Walton type generator) in a neutron flux of 6×10^6 $n/cm^2/sec$. The effects of radiation were studied by external observation of whole embryos and by microscopic examination of normal and irradiated embryos. Differences in neutron sensitivity between the presumptive neural ectoderm and the chordamesoderm were also investigated in vitro. Neutron-sensitivity decreased from the cleavage stage to the tail-bud stage; in the latter no effect was observed. A high frequency of abnormality was observed in mid-blastula and early gastrula stages. The abnormalities consisted of microcephalia, acephalia, cyclopia, and axial distortion. The nervous system in particular was very sensitive to neutron radiation. The irradiated presumptive neural ectoderm wrapping nonirradiated chordamesoderm underwent cytolysis in vitro and no differentiation occurred in it, while the irradiated chordamesoderm wrapped in the nonirradiated ectoderm was never affected and retained its inducing and self-differentiation ability. The results suggested that the neutron-irradiated and damaged cells released a cytotoxic agent. (BBB)

10878 EXPERIMENTAL AND HISTOPATHOLOGICAL STUDY ON GENERALIZED AND MULTIPLE ERUPTIONS DURING ^{60}Co RADIOTHERAPY OF FEMALE GENITAL CANCER. Matsuoka, Yoshito (Kumamoto Univ., Japan). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 14: 47-8(Jan. 1967).

The etiology of generalized skin eruptions during ^{60}Co radiotherapy was investigated experimentally by serological procedures and histopathological studies undertaken on the skin lesions. Skin tests and passive cutaneous anaphylaxis tests conducted in ten cases with skin eruptions and 25 control cases were all negative; vaginal discharges and tissue extracts of irradiated uterine cancer were used as antigens. Hemagglutination tests with the endotoxins of Escherichia coli, Streptococcus hemolyticus, and Staphylococcus aureus as antigen were performed in seven cases with eruptions and 37 control cases. Only an elevation of agglutination titers against S. aureus was noted in the acne stage; no distinct variation of the titer with the other two antigens was demonstrated. Histopathological findings of the dermal lesions showed similar changes to those seen in urticaria, eczema, and erythema. At first, histological changes occurred in blood vessels and connective tissue. In the dermis, collagen bundles showed edema and homogenization, and, in some areas, fragmentation. The blood vessels were dilated and revealed edema of their walls, with endothelial proliferation. Furthermore, perivascular infiltration by lymphocytes, eosinophils, and neutrophils occurred. The epidermis was irregular, showing acanthosis with hyperkeratosis in some areas and considerable intercellular edema (spongiosis) in others. In one case the intraepidermal abscess was composed almost entirely of neutrophils. It is suggested that the denatured tissue products resulting from therapy play some role in the etiology of this complication, and allergic reactions from endotoxins of bacterial flora in genital and intestinal tracts may also be involved. (BBB)

10879 LASER VERSUS XENON PHOTOCOAGULATION. Vallotton, William W.; Antine, Bartley E. (Medical Coll. of South Carolina Hospitals, Charleston). S. Med. J., 60: 819-22 (Aug. 1967).

Histologic effects and complications resulting from laser and Xe lamp irradiation of the retina are compared. Photomicrographs taken from 2 melanoma-bearing human eyes enucleated 12 hr after producing minimum intensity laser burns showed changes mainly in the pigment epithelium and Bruch's membrane. The pigment epithelium revealed loss of cell nuclei and cell outline. The rods and cones appeared essentially unaltered, as did the remainder of the retina. The changes in the choroid were limited to thickening and vesiculation of the cuticular portion of Bruch's membrane and an increase in the noncellular material producing a decreased number of capillaries in the choriocapillaris. Alteration of alcian blue staining characteristics of the acid mucopolysaccaride overlying the pigment epithelium was shown. Laser burns of moderate intensity, such as used clinically, resulted in alteration of the rods and cones, loss of cells in the outer nuclear layer, and coagulative necrosis in the outer plexiform layer. There was an increase in the number of tissue macrophages present. High intensity burn, above that used clinically, resulted in buckling of the pigment epithelium, fracture of Bruch's membrane and hemorrhage, presumably from the large vessel layer of the choroid, into and through the retina, disrupting retinal architecture in that area and elevating the internal limiting membrane. The histological changes associated with Xe lamp irradiation indicated that the major absorption of energy was at the pigment epithelium. With low intensity burns the inner layers of the retina were spared. However, with the usual intensity of burn, which turns the retina white, all layers of the retina demonstrated immediate coagulative necrosis as well as producing necrotic changes in the choroid. (BBB)

10880 PHOTOCOAGULATION OF RETINA. Campbell, Charles J.; Rittler, M. Catherine M.; Koester, Charles J. (Presbyterian Hospital, New York). Int. Ophthalmol. Clin., 6: 293-318(Summer 1966).

Experimental and clinical studies of ruby laser effects on the retina are reviewed. Areas discussed were absorption and transmission of energy in the different tissues of the eye, effects of beam intensity and exposure time on thermal energy distribution and effects, and histological characteristics of laser-induced injuries. (BBB) (TSS)

10881 IONIZING RADIATION IN APPLIED ENTOMOLOGY. Cadahia, D. Montes, 22: 159-68(Mar.-Apr. 1966). (In Spanish).

A review is given of the present state of experimentation and application of radioisotopes in entomology. Studies on genetics, sterilization, and lethal effects of radiation are included. The practical uses of radiation in the control of insects are summarized under four headings: release of sterile males, development and release of insect races with inferior or lethal genetic characteristics, irradiation of products affected by insects, and irradiation of plants for the production of useful mutations. (J.S.R.)

10882 APLASTIC ANAEMIA IN SUBLETHALLY IRRADIATED MICE GIVEN ALLOGENEIC LYMPH NODE CELLS. Barnes, D. W. H.; Mole, R. H. (Medical Research Council, Harwell, Eng.). Brit. J. Haematol., 13: 482-91(July 1967).

When 10,000,000 lymph node cells from C_3H/H mice were injected intravenously into CBA/H mice on the day after a sublethal exposure to 450 or 600 rads about half the mice developed a fatal aplastic anaemia. Deaths from anaemia occurred between 13 and 142 days later with few of the ordinarily accepted signs of a graft-versus-host reaction. The marrow was grossly aplastic. Haematological and histological observations after 600 rads and experiments with higher midlethal radiation doses and mixtures of C_3H or CBA lymph node or bone marrow cells showed that the allogeneic lymph node cells specifically prevented regeneration of host-type bone marrow. The results are regarded as providing a model of how somatic mutation in immunologically competent cells could be a mechanism underlying the sporadic occurrence of aplastic anaemia in man. (auth)

10883 EFFECTS OF LOW-LEVEL IONIZING RADIATION AND HIGH TEMPERATURE ON THE PHYSIOLOGY AND SURVIVAL OF ALBINO RATS. Ahmed, Shams Uddin. College Station, Tex., Texas A and M Univ., 1965. 110p.

Thesis.

A study was conducted to investigate the combined effects of low level ionizing radiation followed by a high environmental temperature. One hundred and twenty albino rats were assigned to three treatment groups consisting of 40 animals each as follows: a group that received a total accumulated dose of 1000 R in 100 days at the rate of 20 R per day over a 20-hour period on alternate weeks; group that was subjected to irradiation continuously for 50 days to receive a total accumulated dose of 1000 R at the rate of 20 R per day; and a group that served as controls. At the end of irradiation, 20 animals of each group were moved to the heat chamber and subjected to heat stress at temperature of 93°F ± 2.2°F and humidity of 88 ± 4 per cent. The animals were weighed twice weekly during entire irradiation and heat stress period. Rectal temperature and oxygen consumption were taken weekly during heat stress period. The mean rate of gain of continuously irradiated animals was less as compared to fractionated irradiated group and significantly less ($P < .01$) than control animals for forty-nine days of irradiation. The weight loss was observed in all irradiated heat-stressed animals when compared to control during initial two weeks of heat stress. Heat-stressed animals had a higher rectal temperature throughout the experiment than nonheat-stressed animals and had a significantly higher temperature on the day 21, 28, 35, 42 and 49 of heat stress. Oxygen consumption of heat-stressed animals was less during last few weeks of heat stress and significantly less ($P < .01$) on the 48th day of heat stress than those in room temperature. Total RBC was slightly lower and total WBC increased in heat-stressed animals. The hematocrit and hemoglobin concentration were decreased in irradiated heat-stressed animals. A slight decrease in neutrophil percentage and lymphocyte percentage was observed in heat-stressed groups. The weights of pituitary and prostate were depressed slightly while the weights of testes, seminal vesicle, heart, liver, kidney and spleen were significantly depressed ($P < .01$) in the irradiated heat-stressed groups. Microscopic study showed that in the testes of fractionated and continuously irradiated animals, the seminiferous tubules were decreased in size and appeared to be shrunken. The tubular lumen was filled with cellular debris. Germinal cells were degenerated or absent with no normal germinal elements more advanced than spermatogonia visible. Interstitial and Sertoli cells were normal. In nonirradi-

ated heat-stressed animals, few tubules were decreased in size. Spermatozoa were present in the tubules in approximately normal numbers. The spleen of irradiated heat-stressed animals revealed congestion, presence of hemosiderin, some fragmentation of germinal centers, dialation and engorgement of blood vessels of some trabeculi. Kidneys showed some glomerular condensation and some hyaline casts in convoluted and excretory tubules and in some cases in all the heat treatment animals. In some cases kidneys of both irradiated and nonirradiated heat-stressed animals were hemorrhagic. Cortical atrophy of the adrenal glands was observed in irradiated heat-stressed animals while hypertrophy was observed in nonirradiated heat-stressed animals. Epinephrine and nor-epinephrine cells of irradiated and nonirradiated heat-stressed animals were increased when compared to controls. The liver did not present any significant abnormalities in any treatment groups. It was evident from this experiment that combined effects of irradiation and high temperature caused more deleterious effects on different systems than the heat stress alone. (auth)

10884 EFFECTS OF HEAT AND IONIZING RADIATION ON SURVIVAL OF MAMMALIAN CELLS IN CULTURE. Chamberlain, Charles Craig. Los Angeles, University of California, 1967. 182p.

Thesis.

A series of experiments was conducted to determine the effects of heat alone and in combination with x rays on the survival of mammalian cells in culture. L and HeLa cells suspended in growth medium or attached to the surface of glass plates were heated to temperatures between 40°C and 55°C for varying lengths of time. Ability of the cells to produce colonies after treatment was used to indicate survival. In experiments involving radiation combined with heat, L cells were irradiated at either 45°C or 37.5°C with x rays having an effective energy of 1.9 MeV. One preliminary experiment was done using ^{60}Co γ rays. Both HeLa and L cells showed a large temperature coefficient for thermal inactivation when exposed to temperatures between 40° and 55°C. When L cells were heated before, during or after exposure to x-rays, the survival was much less than that predicted on the basis of independent action. When a twenty minute exposure to 45°C was fractionated into two ten-minute heat exposures separated by a recovery period of varying lengths at 38°C, survival was greater than for the single exposure and increased with length of the recovery period. The increase in survival was attributed to recovery from sublethal thermal damage. Recovery occurred in the presence of Actinomycin D and at 24° and 4°C. Some evidence is given indicating that recovery is complete. Electron micrographs made of L cells fixed immediately after heating for twenty minutes at 45°C, and experiments involving the exclusion of trypan blue from cells heated at 45°C indicated little immediate effects on cellular membranes but a slow loss of integrity over a twenty-three hour period. A model is proposed whereby thermal inactivation is attributed to inactivation of critical cellular enzymes. Recovery from sublethal heat damage results from replacement of these inactivated enzymes by synthesis of new enzymes mediated by heat-resistant enzymes. Interaction of heat and radiation is due to thermal denaturation of enzymes involved in repair of radiation damage. Microwave radiation appears to be the method of choice for use in tissue heating since ultrasound may cause release of tumor cells into the circulation. (Disser. Abstr.) (TSS)

Radiation Effects on Plants

Refer also to abstracts 10707, 10717, 10730, 10737, 10739, 10742, 10746, 10747, 10753, 10815, 10854, and 10881.

10885 RADIATION INDUCED ENHANCEMENT OF GEL STRENGTH IN RED SEAWEEDS. Doshi, Y. A.; Rao, P. S. (Central Salt and Marine Chemicals Research Inst., Bhavnagar, India). Indian J. Chem., 5: 342-3(July 1967).

Effect of ^{60}Co, γ radiation (1000°C) on dry seaweeds and their gel strengths was studied. A small initial dose of about 0.5 to 3.0×10^{18} eV/g enhances the gel strengths in Gelidiella acerosa, Gelidium micropterum and Gracilaria miliardetii by 1.3 to 2.5 times. (auth)

10886 ELIMINATION OF X-RAY-INDUCED ABERRANT CHROMOSOMES IN THE ROOT MERISTEMS OF TWO-ROWED BARLEY. Ikushima, Takaji; Ichikawa, Sadao (Kyoto Univ.). Nippon Idengaku Zasshi, 42: 271-8(Aug. 1967).

Frequencies of chromosomal aberrations were examined in three successive cell generations in the root meristem of barley following x-irradiation of seeds with moderate doses. Seeds of a cultivated variety, Schwanhals, of two-rowed Hordeum distichum (2n = 14) were used. The seeds were soaked for 24 hr in the dark at 20°C prior to irradiation with a single dose of 300 R, delivered at a dose rate of 354 R/min. This exposure was selected to induce many chromosomal breaks without causing delayed or abnormal mitotic divisions. Exposures higher than 300 R frequently induced a delay and abnormalities (predominantly stickiness of chromosomes) of mitosis in the same material. Dicentric bridges and acentric fragments observed at anaphase, and dicentrics, rings, and chromosomes with obvious deletions detected at metaphase were scored. Frequencies of these chromosomal aberrations decreased rapidly with the progress of cell generation. Their rapid reduction in number, especially of dicentric bridges, much more rapid than expected, indicated that elimination of the cells carrying aberrant chromosomes occurs in the meristematic cell population. Thus elimination is attributable to the loss of reproductive integrity of the cells carrying such aberrations, probably as a result of the loss of chromosome segments. (BBB)

10887 EFFECT OF DEUTERIUM OXIDE ON CULTURING OF PENICILLIUM JANCZEWSKII. I. GROWTH, NUTRITIONAL FACTORS, AND ANTIBIOTIC PRODUCTION. Nona, D. A. (Univ. of Illinois, Chicago); Blake, M. I.; Katz, J. J. J. Pharm. Sci., 56: 1063-8(Sept. 1967).

Nutritional requirements for culturing the griseofulvin-producing mold, P. janczewskii, in a D_2O environment, and the effects of D_2O on the production of the antibiotic griseofulvin were studied. This constitutes the first report on the detection and isolation of an antibiotic obtained from a deuterated organism. In media containing 50, 75, and 99.6% D_2O protio- and deuterio-carbohydrates were used as carbon sources. Griseofulvin production decreased markedly with increase in D content of the medium, and there was a marked reduction in mycelial dry weights with increase in D_2O in the nutrient. The surface culture technique proved more effective than the shake method for both tissue growth and antibiotic formation. Corn steep solids and vitamin B-complex additives caused an enhancement of both mycelial growth and griseofulvin production in highly deuteriated media. The isotope effect on the mold may be due to an incomplete medium. High D concentrations resulted in the utilization of available metabolites to maintain the nutrition of the isotopically altered mold. The fungus apparently became frugal, meeting only those needs required for survival. Deuterium seemed to interfere with the basic integrity of the mold enzymes that were necessary for antibiotic and pigment production. The morphological changes in the deuterated fungi appeared to be due to a general disruption of the cell enzyme physiology. (BBB)

10888 CONCERNING TEMPERATURE MODIFICATION OF SURVIVAL CURVES FOR YEAST CELLS IN THE POST-IRRADIATION PERIOD. Kapul'tsevich, Yu. G. Radiobiologiya, 7: 367-71(1967). (In Russian).

Studies carried out with Saccharomyces vini yeast irradiated with γ-rays at 72 R/sec indicated that the increase in the lethal effect of radiation observed on reduction of the culture temperature following irradiation from 30 to 10° could not have been attributed to a decreased capacity of yeast cells for recovery from radiation damage. With the reduction of the temperature of post-irradiation incubation, the rate of budding and consequently of potential damage development decreased to the same extent as the amount of recovery, after the irradiated yeast was cultured at 10° for a sufficiently long time, the recovery was exactly the same as that for irradiated yeasts cultured at 30°. Experiments with cultures at 10° and 30° and irradiated with 65 kR doses indicated that the vitality level produced by culturing at either of these two temperatures was retained for a considerable number of generations and was still exhibited after recovery from radiation effects. (JPRS)

10889 EFFECTS OF X RAY AND NEUTRON IRRADIATION ON SEEDS OF PHASEOLUS MUNGO L. Jana, Manas K. (Indian Inst. of Tech., Kharagpur, India). Genet. Agr., 18: 616-28(Dec. 31, 1964).

Of the six doses of x rays (5,000, 10,000, 20,000, 40,000, 60,000, and 80,000 R) used for irradiating dry seeds of black gram variety T.9, 80,000 R proved to be lethal dose. At 60,000 R, about 46 percent of the plants survived up to harvest and maximum number of mutants were recovered. Of the two doses of neutrons, 4×10^{12} np/cm^2 and 8×10^{12} np/cm^2, the latter proved completely lethal. The percentage of survival up to harvest was about 32 with the former dose. After irradiation, the germination was not affected, at any of the doses used, but sprouting was delayed. The seedling lethality was mainly due to lack of growth of roots, and most of the seedlings died within 20 days. The abnormalities in R_1 generation were mostly observed in the shape, size and color of the first pair of leaves and trifoliate leaves. The height and number of branches diminished. Flowering was delayed by about 10 to 15 days and the flowering period became longer. The fertility was greatly impaired with radiations. The frequency of semi-sterile plants (50 percent pollen sterile) was maximum at 60,000 R and at 4×10^{12} np/cm^2 neutrons and minimum at 5,000 R x rays. The

number of fruits produced per plant varied inversely to the dosage. In the R_2 generation various aberrant types were recovered and these could be grouped into (i) chlorophyll deficient, (ii) sterile and (iii) vital types. Among the mutants showing morphological abnormalities, x irradiation affected mainly the flower and neutrons affected the leaf characters. (auth)

10890 NODULATION OF MEDICAGO SATIVA PLANTS FROM SEEDS IRRADIATED WITH X RAYS. Visona, L.; Vanossi Este, S.; Caprotti, M. (Univ., Pavia, Italy). Genet. Agr., 18: 641-69(Dec. 31, 1964). (In French).

Two local strains (Cremonese and Massinigo) and one variety (99/100) of Medicago sativa, are differentially affected by x ray treatment when symbiosed with Rhizobium melitoti. The dose of 90 kR has a clear-cut negative effect on nodulation in the three populations: 60 kR effect only the 99/100 variety. Mortality was always correlated to dosage. The effect of radiations in the presence of β-indolylacetic acid (ABIA) was examined only in the strain Cremonese. Mortality was correlated with the dosage/mortality previously found. The plants inoculated or treated with ABIA are more radiosensitive than plants not inoculated or grown without auxine. A correlated increase in the number of nodules and the development of rootlets is statistically significant only among surviving plants. (auth)

10891 TREATMENT OF TOBACCO. Boenig, Herman V.; Lambertson, W. A.; Braun, W. J.; Myers, H. S. (to United States Atomic Energy Commission). U. S. Patent 3,358,694. Dec. 19, 1967.

This patent relates to a method of modifying tobacco to produce less irritants when burned by exposing it to at least one megarad of gamma radiation. (AEC)

Radiation Effects on Microorganisms

Refer also to abstracts 10515, 10740, 10752, 10754, 10790, 10854, and 10861.

10892 THE INFLUENCE OF ULTRAVIOLET LIGHT ON THE KINETICS OF PLAQUE GROWTH OF BACILLUS SUBTILIS PHAGES SP 3 AND SP 8. Kalab, D. (Bioveta, National Enterprise, Ivanovice na Hane, Czech.). Acta Virol. (Prague), 11: 453-7(Sept. 1967).

The influence of uv radiation on plaque growth of bacterio phages was investigated in the two serologically unrelated phages SP 3 and SP 8 that are virulent for B. subtilis. These two phages differ in uv sensitivity and were suitable for the study of the relation between uv killing and delay in plaque growth that reflects the sublethal photochemical modification of their DNA. A low pressure Hg vapor lamp with a principal emission at 2537 Å was used. Inactivation curves of both phages were exponential at low uv doses; this indicated the phages one-hit character. The $D_{37\%}$ values (one lethal hit) were 75 and 350 erg/mm^2 for SP 3 and SP 8 phages, respectively. Irradiation retarded the plaque growth of survivors as compared with nonirradiated controls. This effect reflected the increase of the latent period of irradiated phages in the host cell. The retardation of plaque growth of SP 3 and SP 8 phages became more pronounced with increases in the uv dose and it depended on their uv sensitivity. The effect could be detected in both phages even after very low uv doses (below $D_{37\%}$). The relation of this effect to the lethal action of uv irradiation on extracellular bacteriophage is discussed. (BBB)

10893 STERILIZATION OF BIOLOGICALLY ACTIVE POLYSACCHARIDE COMPLEX ISOLATED FROM B. PRODIGIOSUM. Waisberg, G. J.; Giwental, N. I.; Taranenko, L. A. (Central Inst. for Medical Education, Moscow). Wiss. Z. Humboldt-Univ., Berlin, Math.-Naturwiss. Reihe, 16: 161-3(1967). (In German).

Ionizing irradiation has a marked ability to destroy Bacterium prodigiosum (Serratia marcescens). After irradiation the number of free reduced groups increases markedly, reaching greater values than after autoclaving. As calculated in terms of glucose reduction activity, after exposure to 2.5×10^6 rad the activity was decreased by 21.08%, and after 5×10^6 and 10^7 rad it was decreased by 23.7 and 25.7%, respectively. The biological activity of B. prodigiosum was evaluated by its ability to protect mice against a lethal injected dose of pathogenic Escherichia coli O111. The B. prodigiosum was given intraperitoneally to the mice in a dose of 2 mg/mouse 24 hr before the E. coli injection. (BBB)

10894 INDIRECT INDUCTION OF PROPHAGE λ BY ULTRAVIOLET IRRADIATIONS. Devoret, Raymond; George, Jacqueline (CNRS, Gif-sur-Yvette, France). Mutat. Res., 4: 713-34(Nov.-Dec. 1967). (In French).

When Escherichia coli K 12, lysogenic for phage λ, was irradiated with ultraviolet light, prophage λ immediately entered the vegetative state (direct ultraviolet induction). The induction stimulus produced by ultraviolet irradiation could be transferred by conjugation from an irradiated $F^+\lambda^-$ strain to a non-irradiated $F^-\lambda^+$ strain (indirect ultraviolet induction). Some of the properties of indirect and direct ultraviolet induction are compared in this paper. The efficiency of indirect induction was 50% of that obtained by direct induction at optimal ultraviolet doses. Both processes showed a two-hit curve at increasing ultraviolet doses. There was a synergistic action of direct and indirect induction when applied to the same recipient strain. These two processes appeared to be closely related; they could share a common mechanism which could lead to prophage induction. Indirect induction was mediated through the transfer of an irradiated sex factor such as factor F. In Hfr × F^- conjugation, in which factor F was very seldom transmitted to the recipient strain, no indirect induction occurred. These results eliminated the possibility that chromosomal DNA was responsible for indirect induction. They suggested instead that an extrachromosomal determinant (factor BR) was involved. Factor RB was nonspecific; it induced various unrelated inducible episomes. It was unstable, having a half-life of about 8 min at 37°. Different kinds of data provided indirect evidence in favor of the hypothesis that factor RB was constituted of ultraviolet irradiated DNA. Experiments suggested that factor RB could be an irradiated replicon, such as factor F or factor col I. These two replicons were small enough to be wholly transmitted to the recipient cell. Prophage λ induction could be triggered in the absence of a direct effect of ultraviolet light upon the prophage or upon the repressor which was synthesized under the control of the prophage. (auth)

10895 UV-SENSITIVE MUTANTS OF CHLAMYDOMONAS REINHARDI. Davies, D. Roy (Atomic Energy Research Establishment, Wantage, Eng.). Mutat. Res., 4: 765-70(Nov.-Dec. 1967).

Mutant strains of Chlamydomonas reinhardi that were highly sensitive to uv radiation were induced by nitrosoguanidine. This enhanced response was due to a defective dark repair capacity. The effect of photoreactivating light was not dose-modifying in the mutants, but a comparison of the doses required to reduce the survival level to 10%, gave photoreactivating factors as large as 45 in some of the mutants, whereas in the parental wild type strain it was 4.7. By crossing mutants with each other and with the wild type, it was shown that the differences in uv response were due to single gene differences, and that several loci were involved. Two of the loci studied were shown to influence survival in different ways; the double mutant was more sensitive than either parent. (auth)

10896 SPORES OF MICROORGANISMS. XIX. HEAT AND UV RESISTANCE OF SPORES OF BACILLUS CEREUS PRODUCED ENDOTROPHICALLY IN THE PRESENCE OF β-2-THIENYL-ALANINE. Weisova, Helena; Vinter, V.; Starka, J. (Charles Univ., Prague). Folia Microbiol. (Prague), 11: 387-91(Sept. 1966).

Bacillus cereus spores were produced endotrophically in the presence of β-2-thienylalanine. Heat and uv resistance and the content of dipicolinic acid (DPA) of such spores were studied and compared with the same properties of spores formed under optimal conditions in a culture medium. It was found during uv irradiation of the spores that radioresistance of the spores did not significantly differ from the controls. Slightly higher uv resistance of the spores from the peptone medium used might have been caused by a protective effect of peptone, traces of which might remain on the cells even after washing. When heat inactivation was carried out at 85°C, the results showed that inactivation of the spores formed in a bactopeptone medium had a biphasis course with a break at about 15 min heating. The heat inactivation of spores in $CaCl_2$ solution followed the same kinetics. On the contrary, a killing curve of the spores formed in the presence of thienylalanine was on monophasic exponential character from the very beginning. However, heat resistance of the spores calculated from the final slope of inactivation curve remained the same: $D_{85°C} = 12$ in spores from the peptone medium, $D_{85°C} = 13$ in spores from both $CaCl_2$ and analog solutions (D = time in minutes required to kill 90% of the spores at a given temperature). The DPA content in spores produced in distilled water was about half that of spores from peptone and $CaCl_2$ solution. The spores formed in $CaCl_2$ solution contained the same DPA concentration as controls and the spores formed in the presence of the analog. DPA concentration in the spores was thus not influenced by the analog. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 10881 and 11103.

10897 (NYO-3734-2) CHRONIC TOXICITY STUDIES ON LOW-DOSE IRRADIATED BANANAS. Quarterly Report No. 2. Morgareidge, Kenneth (Food and Drug Research Labs., Inc., New York). Jan. 4, 1968. Contract AT(30-1)-3734. 37p. Dep. CFSTI.

Prior to processing into banana powder, fresh green bananas were irradiated with ^{60}Co γ rays to a dose of 20- and 40 KR. Following irradiation and processing, the bananas were sealed in cans and shipped to laboratory facilities where they were fed to dogs and rats. The irradiation delayed ripening of the fruit, but temperature and ethylene oxide treatments ameliorated this effect. The irradiated banana powder was fed to dogs and rats to determine nutritional value and palatability. No significant differences were seen between the control diets (commercial) and the irradiated banana powder diet in regard to any of the criteria. (E.R.B.)

10898 PROLONGING THE KEEPING QUALITY OF FOOD BY IRRADIATION. PART II. RESULTS OF IRRADIATION OF INDIVIDUAL FOOD GROUPS. Uhlig, K. (Ministerium fuer Grundstoffindustrie, Abt. Kernenergetik, Berlin). Isotopenpraxis, 3: 345-51(Sept. 1967). (In German).

The results of the irradiation of different groups of food stuffs are discussed. Foods treated included meat and meat products, fish and fish products, fruit, vegetables and potatoes, and grain and grain products. The effectiveness of radiopreservation is evaluated. (E.R.B.)

10899 AUTOCIDAL CONTROL OF THE CODLING MOTH BY RELEASE OF MALES AND FEMALES STERILIZED AS ADULTS BY GAMMA RADIATION. Proverbs, M. D.; Newton, J. R.; Logan, D. M. (Canada Dept. of Agriculture, Summerland). J. Econ. Entomol., 60: 1302-6(Oct. 1967).

Laboratory and field experiments designed for evaluation of autocidal control of the codling moth, Carpocapsa pomonella, by release of γ-radiosterilized males and females are described. It was found that larval progeny was reduced 80% when adult moths were exposed to 48 Krad of γ radiation in an atmosphere of carbon dioxide and then caged with untreated moths at a ratio of 15 irradiated males and 15 irradiated females to one untreated male and one untreated female. In an abandoned two-hectare apple orchard, the release of 271,000 irradiated (50 Krad) male and female moths in 1964, and 478,000 in 1965 reduced the amount of apple injury at harvest from ~60% in 1963 to 1.6% in 1964 and 0.3 % in 1965. (BBB) (TSS)

10900 THE EFFECT OF γ RADIATION OF ^{60}Co ON THE EPIPHYTIC MICROFLORA OF GRAPE AND POMEGRANATE. Pantyukhina, E. L.; Kondrat'eva, E. V.; Voropaeva, O. G. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk UzSSR, No. 10, 48-51(1966). (In Russian).

In studying methods for preventing the spoilage of agricultural products, the microflora of grape and pomegranate, irradiated with the water-shielded γ facility of the Institute at doses of 100, 300 and 500 krep, was examined. Identical fruits, kept under the same conditions (3 months at 12°C) were used for comparison. The fruits were exposed in bulk, under loose condition, and packaged in polyethylene bags. The unirradiated grapes exhibited a great variety of bacteria and molds; the bags did not afford any protection. The number of fungi and molds on the grapes decreased with increasing dose. On the unirradiated pomegranate 16 types of molds were observed; this was reduced to two on the specimens exposed to 100 krep. No bacteria were found on the open, highly irradiated fruits. The number of molds decreased with increasing total dose but increased again at 500 krep. This is probably due to activation of fruit ferments and changes in the permeability of the cell membranes. The larger number of microorganisms is probably due to the prevailing favorable conditions, such as the low acidity of the grape juice and the presence of easily assimilable glucose. The unsatisfactory behavior of the polyethylene bags is probably due to the fact that they helped to create a highly humid environment. (TTT)

10901 CLINICAL USE OF COBALT-IRRADIATED FASCIA LATA. Falls, Harold F.; Sloan, David B. Jr.; Bryson, Jerry M. (Univ. of Michigan, Ann Arbor). Amer. J. Ophthalmol., 64: 426-7(Sept. 1967).

The use of ^{60}Co γ-irradiated autopsy tissue for repair of the eyelids is reported. The degree of immunologic tolerance, incidence of infection, maintenance of surgical correction, and final cosmetic appearance were evaluated. The use of γ-irradiated fascia lata avoided most of the complications associated with other materials. Enough tissue could be obtained during one autopsy to supply many cases. The material, moreover, was always available in the operating room for elective and emergency use. Microbiologic cultures were made of samples of fascia immediately after irradiation and at the time of its use; all cultures were negative despite the fact that fascia was stored for several months at room temperature. Results were satisfactory for the 17 eyelid procedures in which it was used. In a follow-up of 12 months, there was no evidence of host rejection. The amount of lid elevation obtained with surgery was maintained without exception. Cosmetic appearance was as good as could be expected when the frontalis muscle is utilized for lid elevation. There were no infections and no complications that could be attributed to the use of the homologous material. (BBB)

10902 UNIFORM GAMMA IRRADIATION OF BULK GRAIN MATERIAL. Reiback, E. M.; Kuhl, O. A. (to United States Atomic Energy Commission). U. S. Patent 3,360,646. Dec. 26, 1967.

This patent relates to irradiation apparatus utilizing gamma rays for the uniform irradiation of bulk material. The bulk material such as grain is gravity fed through a vertical passageway through and across which passes an array of spaced grid tubes containing the sources of gamma rays. Construction and spacing of these tubes provides application of relatively uniform dosages to the grain while at the same time prevents any of the material from receiving an excess of radiation. (AEC)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

10903 THE ROLE OF NUCLEAR RESEARCH IN S. A. S. Afr. Mining Eng. J., 78: 1875; 1889(Aug. 11, 1967).

Advances in nuclear reactor technology in South Africa are briefly reviewed, with emphasis on fuel fabrication and processing. One major problem considered is the economic production of nuclear energy by obtaining a long burn-up time of the fuel. It will be necessary to increase the working temperature to obtain higher efficiency in the process of converting energy in the form of heat to electricity. Tests are required to determine the rate of production of fission products and new fissionable material, as they have a direct bearing on the maximum burnup obtainable with a particular fuel element. It is important to know the influence of these impurities and the newly produced fissile products, e.g., Pu, on the neutron spectrum inside the fuel element, yet very little is known in this respect. The following research approach is described: studies on the fundamental behavior of fuel material under irradiation using small samples; technological studies on the fuel element, either in sections or of diminished dimensions; and studies of the evolution of nuclear characteristics of the fuel as a function of the amount of irradiation. Study of coolants is also outlined. (BBB)

10904 OUR NUCLEAR FUTURE. PART I. Dunsmore, Chester L. (Atomics International, Canoga Park, Calif.). Power Eng., 71: 48-51(June 1967).

Economics of nuclear vs fossil fuel use in electric power generation are compared, and some present and future trends in nuclear fuel development are discussed. The annual saving in fossil fuel resources through the use of nuclear fuel, based on estimates of nuclear growth, is considered. By the year 2000, the use of fossil resources as fuel may begin to decrease. Nuclear reactions involved in fission of ^{233}U, ^{235}U, and ^{239}Pu are examined in terms of efficiency of the processes. Conversion of U to Pu and breeder reactions are also discussed. In the large thermal Pu converters at Hanford and Savannah River, the conversion ratio is less than 1. A comparatively small amount of Pu is also produced in the thermal power reactors now in operation. It might be theoretically possible to breed on a ^{233}U or ^{239}Pu cycle in a thermal reactor; however, not all neutrons generated are available for use. Some are captured parasitically by core structure or by control rods, and some escape from the core to be absorbed in shielding. Thus, conversion ratios for thermal power reactors vary between 0.4 and 0.6. Production reactors are designed on a much different basis, and get ratios near 1. For Pu in fast reactors, improved self-absorption characteristics and reduction of parasitic absorption in core lead to a much more efficient use of neutrons at high energy levels. The first commercial breeders will probably achieve ratios of at least 1.2 to 1.3. (BBB)

10905 VENTED NUCLEAR REACTOR FUEL ELEMENT. Gatley, John Andrew; Webb, John; Gallie, Reginald Robert (to United Kingdom Atomic Energy Authority). U. S. Patent 3,357,893. Aug. 23, 1965. Priority date Aug. 28, 1964, Great Britain.

A fuel element design of the vented type having a fuel-containing protective sheath of elongated form is given. A vent path unobstructed by fuel has a permanently open communication with the fuel adjacent at one end. The other end of the vent path has an outlet with the exterior surroundings of the sheath for discharge into the surroundings of gases released by the fuel during operation. (J.C.W.)

10906 METALS REFERENCE BOOK. VOLUME I. FOURTH EDITION. Smithells, Colin J. New York, Plenum Publishing Corp., 1967. 400p.

A summary of data relating to metallurgy and metal physics is presented in the form of tables and diagrams with a minimum of descriptive matter. A bibliography of original source material follows each chapter. Included are sections on general physical and chemical constants, line spectra of elements, crystallography, geochemistry, thermochemical data, physical properties of molten salts, and metallography. (L.C.L.)

10907 METALS REFERENCE BOOK. VOLUME III. FOURTH EDITION. Smithells, Colin J. New York, Plenum Publishing Corp., 1967. 493p.

A summary of data relating to metallurgy and metal physics is presented in the form of tables and diagrams with a minimum of descriptive matter. A bibliography of original source material follows each chapter. Included are sections on the properties of metals and alloys categorized as elastic, electrical, general physical, mechanical, radiating, special magnetic, and thermoelectric. Methods and standards for mechanical testing are discussed briefly. The properties and selection of lubricants are given. Data are compiled on casting alloys and foundry materials and methods, refractory materials, fuels, heat treatments, masers and lasers, electroplating and metal finishing, and brazing, soldering, and welding. (L.C.L.)

10908 METALS REFERENCE BOOK. VOLUME II. FOURTH EDITION. Smithells, Colin J. New York, Plenum Publishing Corp., 1967. 343p.

A summary of data relating to metallurgy and metal physics is presented in the form of tables and diagrams with a minimum of descriptive matter. A bibliography of original source material follows each chapter. Included are sections on equilibrium diagrams, gas-metal systems, and diffusion in metals. (L.C.L.)

Corrosion and Erosion

Refer also to abstracts 10940, 10947, 11007, and 11018.

10909 (AECL-2794) THE INTERPRETATION OF A TRANSMISSION ELECTRON DIFFRACTION PATTERN FROM THIN (≤2000 Å) ZrO_2 FILMS. Ploc, R. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Nov. 1967. 51p. Dep. CFSTI. CAN $1.50.

An attempt was made to determine the mode of ZrO_2 formation on bulk zirconium at 300°C in 760 torr of dry oxygen. Films of ZrO_2 <2000 Å in thickness were chemically removed from their substrates and studied in transmission in an electron microscope. An interpretation of the Zr/ZrO_2 epitaxy on a Zr (0001) is given. All films contained small oxide crystallites, which ranged in size from the detection limit (~30 Å) of the electron microscope to about 250 Å. It was suspected that a significant portion of the film was relatively amorphous in regions between crystallites but this could not be experimentally proven. (auth)

10910 (ANL-7335) CALCULATIONS ON THE KINETICS OF OXYGEN SOLUTION IN TANTALUM AND NIOBIUM IN A LIQUID-SODIUM ENVIRONMENT. Kassner, T. F.; Smith, D. L. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 22p. Dep. CFSTI.

The parabolic rate constants for oxygen solution in tantalum and niobium in low-oxygen sodium were calculated as a function of temperature, oxygen concentration in sodium, and initial oxygen concentration in the refractory metals. The results were obtained at 500 to 800°C, oxygen concentrations in sodium from 1 to 20 ppM, and initial oxygen concentrations in the refractory metals from 0 to 0.10 at. % oxygen. The activation energy for the solution process was less than the activation energy for oxygen diffusion in the refractory metals. At low oxygen concentrations in sodium, plots of the logarithm of the parabolic rate constants versus reciprocal temperature were nonlinear for low initial oxygen concentrations in the refractory metals. Also, on the basis of phase equilibria calculations in the Ta–O–Na and Nb–O–Na systems, the conditions of temperature and oxygen concentration in sodium were predicted over which the phases tantalum and Ta_2O_5, and niobium, NbO, and NbO_2 are thermodynamically stable in sodium. (auth)

10911 (BNWL-520) CORROSION AND BORON DEPOSITION IN BORIC ACID SOLUTIONS. Bloom, G. R.; Demmitt, T. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

The existence and significance of potential corrosion and B deposition problems associated with employing boric acid (H_3BO_3) as a neutron poison in the D_2O moderator of the PRTR to permit operation with a higher power density core were studied. Pilot plant tests of a dump valve, shim rod assembly, and process shroud tube bellows assembly demonstrated the potential for localized Al corrosion in the process shroud tube bellows assembly. No other significant corrosion should result. Boron deposition in the moderator did not exceed 3 $\mu g/cm^2$ area. Using 92% enriched B, the reactivity worth would be ~1.5 to 2.1 milli-k at full power, well within the reactivity control capabilities. Reactor critical tests showed no measurable change in core reactivity. (F.S.)

10912 (EURAEC-1932) QUARTERLY REPORT NO. 18 [ON STRESS CORROSION OF STAINLESS STEELS], APRIL 1–JUNE 30, 1967. Chaudron, G. (Centre National de la Recherche Scientifique, Paris (France)). Contract 059-65-1-TEEF (RD). 15p. (EUR-3756). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The stress corrosion of stainless steel was studied and the influence of the structure of the steels and the effect of a noble metal such as Pt addition to the steel were determined. The part played by martensite and austenite in stress corrosion was noted. The resistance to stress corrosion of austeno-martensite steels was due to an electrochemical mechanism caused by the martensite and the electronegative protection of the austenite. The addition of Pt to a Cr–Ni type steel intensifies the process of triangular cracking in boiling solutions of magnesium chloride. Both corrosion and pitting were found to depend on the physical and chemical surface conditions. (F.S.)

10913 (ORNL-TM-2010) COMPATIBILITY OF DISPERSION STRENGTHENED ALUMINUM WITH URANIUM MONOCARBIDE. Vernard, J. T. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A series of experiments on the compatibility between sintered aluminum products and uranium monocarbide have been performed. These experiments tested sintered aluminum products containing 10 wt % oxide against hypostoichiometric, stoichiometric, and hyperstoichiometric uranium monocarbide at 450 to 625°C. The activation energy for the growth of the reaction product layer was determined to be approximately 84 kcal/mole for 4.8 wt % C fuel and approximately 92 kcal/mole for 4.1 wt % C fuel. A survey of earlier experiments in this system is included. (auth)

10914 (SC-DC-67-1632) HIGH-TEMPERATURE METALLIC OXIDATION. Levine, H. S. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 17p. (CONF-670935-7). Dep. CFSTI.

From 3rd International Symposium on High Temperature Technology, Pacific Grove, Calif.

The kinetics of oxide film growth on metals are postulated following Wagner's parabolic law. Facets discussed include reaction rates, oxide-gas boundary conditions, reactions in air and pure oxygen, relative oxygen demand, interstitial diffusion, and multiphase systems. (P.G.C.)

10915 (WERL-1114-3) HYDROGEN ACCUMULATION RATES WITHIN THICK-WALLED TUBES OF Fe–Cr AND Fe–Cr–Ni ALLOYS DURING EXPOSURE TO HIGH-pH, HIGH-TEMPERATURE, PRESSURIZED WATER CONTAINING DISSOLVED HYDROGEN. Pement, F. W. (Westinghouse Research Labs., Pittsburgh, Pa.). June 1967. Contract AT(11-1)-Gen-14. 41p. Dep. CFSTI.

Hydrogen accumulation rates in evacuated bulbs of 347 stainless steel, Fe–Ni–Cr Alloy 600, and 410 stainless steel with or without platings of Ni or Cr were determined during extended exposures to hydrogen-bearing, pressurized, high-pH water at 575 ± 5°F. Hydrogen accumulated least in the 347 stainless steel bulb and was almost eliminated by inclusion of a Zr–V getter. The 410 stainless steel bulbs accumulated the greatest quantities of hydrogen but the behavior was markedly influenced by the plating element. Tests to bond Zircaloy-2 to stainless steel were also conducted. (auth)

10916 (SC-T-67-0958) THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ABOUT CONJUGATED FORMATION OF SEVERAL LAYERS IN DRY CORROSION. Valensi, G. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Paper Given at Pittsburgh International Conference on Surface Reactions, 1948. 27p. Dep. CFSTI. JCL $2.60 fs, $1.07 mf.

It is possible to calculate global attack constant and composition of double layer, when a metal holding two oxides is corroded by oxygen. Results from practical equivalence between diffusional and electrochemical theories are verified in case of two layers. The same differential equations system is obtained, and it is shown how Price's method for establishing Wagner's equation can be generalized. If there is no coating at initial time, a simple process of integration is suggested, whose interest consists principally in its validity for solving the same problem when layers are more than two. It appears that under definite physical conditions, composition of product must remain constant. Experimental methods are described. The results obtained in copper oxidation studies are in good agreement with theoretical formulas. Abnormal results may be due to inadequate conditions and injurious influences of initial film from atmospheric corrosion and gases occluded in metal. (auth)

10917 ADSORPTION MAXIMA FOR ANION ADSORPTION ON METAL SURFACES. Dreyer, I.; Dreyer, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig), 236: 107-10(1967). (In German).

With the help of ^{35}S-labeled Na_2SO_4 the adsorption of SO_4^{2-} at 20 to 80°C on Zr, Cu, and Ni surfaces was investigated. At 80°C the adsorption maximum appeared on Zr and Ni surfaces. For an explanation of this the formation of oxide layers and related changes in the binding ratios between metal and adsorbed anions were investigated. (tr-auth)

10918 DETERMINATION OF TANTALUM MASS TRANSFER IN Pu–Co–Ce LIQUID METALS BY GAMMA SCANNING. Biery, J. C.; Cushing, C. R. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Appl., 4: 109-20(Feb. 1968). (LA-DC-8779).

The mass transfer of tantalum in Pu–Co–Ce melts was studied by gamma-scanning capsules containing radioactive tantalum in contact with the liquid metal. Eight experiments were run with melts of 5- and 8-g Pu/cm^3 at 700 to 750°C at the hot zones and with 25°C/in. of longitudinal temperature gradient. The results show all mass transfer rates in tantalum capsules to be less than 1 mil/year and in most cases <0.2 mil/year when the source and sink are not closely coupled. A carbon addition to the system appeared to be deleterious since, in one experiment with all capsule surfaces carburized, rates were accelerated by a factor of 10. (auth)

10919 APPARATUS FOR SIMULATION OF TIME-TEMPERATURE-PRESSURE RE-ENTRY ENVIRONMENTS. Grimm, T. C.; Lucarelli, L. A. (McDonnell Co., St. Louis). pp 17-23 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

To properly evaluate oxidation resistant-coated refractory alloy systems for use on re-entry vehicles, it is necessary to subject these systems to the time-temperature-pressure profiles, which will be encountered during re-entry. To simulate re-entry environments, a facility was assembled, which allows for synergistic testing of specimens at temperatures to 4000°F and at flowing air pressures as low as 10^{-3} torr. To date, the apparatus was used to conduct re-entry profile tests on McDonnell LB-2, McDonnell TS-137, and SylcorR512A coated Cb-752 niobium alloy, McDonnell L-7 and Chromalloy W-3 coated TZM molybdenum alloy, and McDonnell L-7 and Chromalloy coated tungsten–2% thoria alloy. (auth)

10920 SATURATION WITH BERYLLIUM BY DIFFUSION. Zemskov, G. V.; Mel'nik, P. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.), No. 3-4, 240-2(Mar.-Apr. 1966).

Specimens of Fe, Mo, and stainless steel are diffusion coated at 800 to 1250°C in a mixture of solid powders of 65% Be, 30% Mg and 5% $MgCl_2$. A study is made of the hardness, case depth, microstructure and oxidation resistance (in air) of coatings, depending on temperature and time of diffusion coating. (auth)

10921 HAFNIUM ALLOYS. Morton, Peter Harlow; Clark, Peter Vincent McDonald (to Imperial Metal Industries (Kynoch) Ltd.). British Patent 1,095,807. Dec. 20, 1967. Filed Dec. 2, 1965.

Hafnium-base alloys are described which have improved tensile strength without significant deterioration of corrosion resistance. One or more of the beta-stabilizing elements Nb, Cr, Mo, Ni, or Fe and one or both of the alpha stabilizing elements Sn and Al are included. The total amount of alpha and beta stabilizers does not exceed 5%. (F.S.)

10922 FORMING UNIFORM THICK OXIDE LAYER ON MATERIAL. Watson, R. D.; Russell, N. H.; Sochaski, R. O. (to Atomic Energy of Canada Ltd.). Canadian Patent 770,080. Oct. 24, 1967.

A method of coating Zircaloy-2 with a tightly adhering coat of light brown zirconium dioxide 0.0005 to 0.008 in. thick is described. After roughening the alloy surface it is heated at about 650°C in the presence of oxygen for ~24 hours. The coating does not flake or chip and resists wear and corrosion by water in a reactor environment. (F.S.A.) (Canada)

Preparation and Fabrication

Refer also to abstract 12006.

10923 (COO-1587-2) THE EFFECT OF SURFACE TENSION ON THE SINTERING ROLE OF METAL ALLOYS. Technical Progress Report. Hirschhorn, J. S. (Wisconsin Univ., Madison). Dec. 1, 1967. Contract AT(11-1)-1587. 3p. Dep. CFSTI.

Work on the effect of O on the sintering rates of silver was completed. No final results have been obtained on the determination of the sintering rates of various solid solution alloys, for which surface tensions are known. The alloy being investigated is the Cu-Sn system. (F.S.)

10924 (DRI-2437) A FUNDAMENTAL INVESTIGATION OF THE ALLOYING BEHAVIOR OF THE RARE EARTHS AND RELATED METALS. Final Report. Lundin, Charles E.; Yamamoto, Albert S. (Denver Research Inst., Colo.). Sept. 1967. Contract AT(11-1)-1298. 468p. Dep. CFSTI.

The alloying behavior of Nd-Pr, Gd-Y, Gd-Sm and Sm-Y systems was studied. The deviation from solution ideality, calculations of free energies, and enthalpies and entropies of mixing were used as criteria. Variables considered were atomic diameter, crystal structure, electronegativity, electronic structure, and valence. The Nd-Pr system is thermodynamically ideal and there are no variables introduced. Crystal structure is the variable introduced in the Gd-Sm system. Excess enthalpy and entropy cause strain in the alloys. The variable in the Gd-Y system is electronic structure but ideality of the complete solid solution exists. In the Sm-Y system, the variables were crystal and electronic structure. The thermodynamics are similar to those of the Gd-Sm system. The difference in electronic structure is negligible in the Gd-Y system whereas the crystal structure variable in the Gd-Sm system caused a large negative deviation from an ideal solution. Combining these two gives the conditions found in the Sm-Y system. (F.S.)

10925 (ORNL-TM-2014) NUMERICAL METHODS FOR SINTERING BY VOLUME DIFFUSION. King, Roy Thomas (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 123p. Dep. CFSTI.

Thesis. Submitted to Carnegie-Mellon Univ., Pittsburgh, Pa.

The Cauchy integral equation is used as a basis for determining the concentration gradient normal to the boundary at all points on the boundary in a two-dimensional region on which the concentration of a diffusing species satisfied Laplace's equation, and on whose boundary the concentration is specified. Numerical methods based on this principle have been developed for treating volume diffusion controlled migration of arbitrarily shaped boundaries. These techniques are described, tested, and applied to the sintering of a rod to a rod and a rod to a plane. Calculations of the volume diffusion coefficient for copper and silver systems to which the results are applicable indicate that neck growth in these systems proceeds one to two orders of magnitude too slowly to be accounted for by these results. However, the volume diffusion coefficient calculated from nickel sintering experiments agrees with that obtained from tracer diffusion experiments. (auth)

10926 (UCID-15236) SELECTED BIBLIOGRAPHY ON HYDROSTATIC AND FLUID-TO-FLUID EXTRUSION OF METALS. Lakner, John F. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 23, 1967. Contract W-7405-eng-48. 21p. Dep. CFSTI.

A bibliography is presented on the hydrostatic and fluid-to-fluid extrusion of metals. The bibliography was assembled for background work prior to starting work on extrusion or forming of the brittle or hard-to-work metals: Be, W, Mo, W-Re, and W-Mo-Re. Some of the citations are accompanied by short summaries, but the articles have not been evaluated. In fluid-to-fluid extrusion, a liquid under high pressure forces a billet through a die into a liquid at a lower pressure. Since the system is pressurized on both sides of the die, both total pressure and pressure differential can be adjusted to values where plastic flow can occur without fracture. In hydrostatic extrusion there is no lower (or "back") pressure. Little quantitative data on refractory metal extrusion is available. The references on the effects of pressure on properties have been a source of data necessary for predicting extrusion behavior. The articles on plasticity help to explain extrusion theory. (auth)

10927 (WERL-0029-4) WELDING OF MONEL AND ^{70}Cu-^{30}Ni: CAST-PIN-TEAR AND HOT-DUCTILITY TESTS. Grotke, G. E. (Westinghouse Research Labs., Pittsburgh, Pa.). June 1967. Contract NObs-90029. 34p. Dep. CFSTI.

Results of a continuation of a program to investigate the applicability of Cast-Pin-Tear Test and Hot-Ductility Test techniques to the problem of weld-zone cracking in Monel and Cupro-Nickel alloys are reported. Of thirteen commercial materials tested, six materials (three 70 Cu-30 Ni pipes and three Monel weld metals) were known to have poor welding characteristics. In four instances, the inferior performance of these materials was confirmed by either direct or indirect weldability tests. Hot cracking in the problem Cu-Ni pipe materials is attributed to extremely high phosphorus content. Results of indirect tests of weld metals do not provide a basis for evaluation of these materials. (auth)

10928 (AD-659666) EFFECT OF LANTHANUM AND YTTRIUM ON THE RECRYSTALLIZATION OF MOLYBDENUM. Gol'tsev, V. P. Translated from Dokl. Akad. Nauk BSSR, 10: 196-8(1966). 8p. (FTD-HT-67-29). CFSTI.

Specimens of sintered molybdenum alloys containing 0.06 to 0.2% lanthanum or 0.03 to 0.1% yttrium were vacuum annealed at 1673°K, rolled at 1133°K with a total reduction of 70%, and again vacuum annealed at 1173 to 1873°K to determine the effect of La and Y on recrystallization behavior. It was found that additions of up to 0.1% yttrium or up to 0.2% lanthanum insignificantly increase the temperature of the beginning of recrystallization. On the other hand, even very small additions of yttrium or lanthanum (0.03 to 0.06%) sharply increase the temperature of the end of recrystallization. The temperature range between the beginning and the end of recrystallization of molybdenum alloy containing lanthanum or yttrium is rather wide and reaches 250 to 300°K. In alloy with 0.2% lanthanum, the first recrystallized grains are formed at 1273°K and the recrystallization ends at 1573°K. At 1673°K, the grain growth begins, but the grain size does not exceed 20 to 25 μ. Only at 1873°K does the grain size increase substantially. Lanthanum and yttrium react with interstitial impurities and act as deoxidizers refining the grain boundaries. It appears that the recrystallization behavior of the alloys tested is a result of the presence of finely dispersed particles of the secondary phase, the products of deoxidation. (auth)

10929 ^{60}Co HEAT SOURCE ENCAPSULATION. Angerman, C. L.; King, F. D. R.; Faraci, J. P.; Symonds, A. E. Nucl. Appl., 4: 88-95(Feb. 1967). (DP-MS-67-23).

The properties of nickel- and cobalt-based heat-resistant alloys were studied to determine their suitability as capsules for radioactive cobalt in heat sources. Capsules with 0.1-in.-thick walls can be used with confidence at normal operating conditions of at least 800°C for one year in air. Operation either for longer times or at higher temperatures (up to 1000°C) may be feasible; the limiting properties will probably be grain boundary diffusion by cobalt and creep strength. The most promising alloys currently under study for encapsulating cobalt are: Inconel 600, TD Nickel Chromium, TD Nickel, and Haynes 25. The performance of these materials is being demonstrated in a continuing program of heating tests of experimental radioactive capsules at 850 to 1000°C for extended times. (auth)

10930 HIGH-PURITY VANADIUM. Lei, K. P. V.; Sullivan, T. A. (Boulder City Metallurgy Research Lab., Nev.). J. Less-Common Metals, 14: 145-7(1968).

A method of preparing high purity vanadium for use in fast-breeder reactors is described. The method consists of double-refining calcium reduced, 99.47% vanadium, by reduction of vanadium dichloride to vanadium at the cathode site with metal deposition on the cathode and oxidation and dissolution of vanadium from the anode material as vanadium dichloride which replenishes the vanadium content of the electrolyte at the rate at which it is depleted at the anode. Vanadium crystals are consolidated into ingots by inert-atmosphere melting on a chilled copper plate which reduces the alkali metal contamination. (F.S.)

10931 EXAMPLES OF APPLICATION OF THE ELECTRON BOMBARDMENT FURNACE IN METALLURGICAL CHEMISTRY. Gosse, G.; Lehr, P.; Albert, Ph. Rev. Hautes Temp. Refract., 3: 371-84(Oct.-Dec. 1966). (In French).

High-temperature vacuum reduction of ZrO_2 and HfO_2 by such reducers as C, Si and Al can be performed in an electron bombardment furnace, giving metallic Zr and Hf as the respective end products. These reductions all have a common feature: O_2 is eliminated in the combined state in the form of gaseous suboxides corresponding to the reducers used—CO, SiO and Al_2O. However, at the end of the reduction process, O_2 is also eliminated in a competitive manner in the form of gaseous monoxides of the two base metals—ZrO or HfO. 17 ref. (Rev. Met. Lit.)

10932 FLAME-SPRAYED COATINGS. PART 1. Meckelburg, Ernst Schleif- Poliertech., No. 3, 81-92(Mar. 1967). (In German).

Older (oxygen-acetylene, hydro-oxygen) and newer (detonation, plasma) methods of applying coatings to metallic substrates are reviewed. The advantages and disadvantages of the individual methods are compared and tabulated, together with coating materials suitable for the individual process, base metal temperature, nature of bond established, dimensional limits, coating thickness and tolerances. The properties and processing characteristics of Al, babbit, Pb, bronze, Cu, Mn-bronze, brass, Monel, Mo, Ni, P-bronze, 18-8 stainless steel, Cr stainless steel, low-carbon steel, high-carbon steel, Tobin-bronze, W and Zn coatings are discussed and tabulated (specific gravity, tensile and yield strength, hardness, shrinkage, rate of spraying, spraying efficiency and applications). (Rev. Met. Lit.)

10933 JOINING TECHNIQUES FOR SAP-CLAD NUCLEAR FUEL ELEMENTS. Hallam, R. C.; Burns, W. J. Trans. Can. Inst. Mining Met., 68: 120-5(1965).

Strong, leak-tight joints can be produced by pressure-diffusion bonding of SAP end closures. The use of a conventional Al alloy,

6061-T6, within the joint is required for successful joining of SAP to SAP. Pressure applied by a solid steel wedge and hydraulic press reduces the joint diameter by 5% to ensure intimate contact between mating surfaces. Evaluation of joint quality by a peel test is best. Resistance welding also produces sound joints, although the high electrical and thermal conductivity of SAP materials require high currents for a short duration for sound welds. The rapid response of an electromagnetic system provides a fast following electrode during the highly critical upset period. Thus magnetic force resistance-upset butt welding is an effective process for making end closures on SAP fuel element cladding. The welds have cross-sectional areas greater than the cross-sectional areas of the cladding. (Rev. Met. Lit.)

10934 EXTRUSION OF REFRACTORY METALS IN VACUUM. Pevzner, S. B.; Korneev, N. I.; Skugarev, I. G.; Tugushev, A. S.; Malashenko, Yu. V.; Emel'yanov, V. B. Tsvetn. Metal., No. 8, 86-8(1967). (In Russian).

Specimens of molybdenum and niobium heated to 1600°C in hydrogen and argon atmospheres, respectively, were upset in air to determine the effect of ambient atmosphere on their ductility. Other specimens were heated to and upset at the same temperature (1600°C) in a vacuum of $133.3 \cdot 10^{-4}$ n/m². A special unit which ensures vacuum or a neutral atmosphere in heating and deformation under 1000-ton pressure was used in the experiments. Heating in argon and deforming in air led to gas impregnation of niobium to a depth of 3 mm, an increase in the CO_2 content from 0.02 to 0.06%, an increase in the surface microhardness, and significant cracking of semifinished products, while none of these changes occurred in niobium heated and deformed in vacuum. Similarly, heating in hydrogen and deforming in air produced oxygen saturation of molybdenum to a depth of 0.3 to 0.8 mm which led to embrittlement and surface cracking and failure with a 43% reduction, while vacuum-deformed molybdenum sustained a 60% reduction without cracking. On the basis of the obtained experimental results, a technology has been developed for extruding Mo–Nb alloy ingots, rods, and tubes in a vacuum. A glass fiber-base + graphite lubricant is used in vacuum extrusion at 1400 to 1600°C. For extrusion at lower temperatures (1100 to 1300°C), copper foil is used as lubricant. The developed technology has been successfully applied to the extrusion of rods, tubes, and other semifinished products from two or more dissimilar metals, and also for cladding and diffusion bonding of metals, particularly active metals. Vacuum-tight joints completely satisfying all technical specifications were obtained in rods and tubes from niobium-1Kh18N9T steel, molybdenum-1Kh18N9T steel, and niobium-molybdenum composites. (auth)

10935 ENCAPSULATION OF SAMPLES FOR HIGH-TEMPERATURE POWDER X-RAY DIFFRACTOMETRY. Michel, David J.; Ryba, Earle Norelco Rep., 14: 25; 36(Jan.-Mar. 1967).

Encapsulation of rare earth-Zn intermetallic compounds in Be foil prevents oxidation of material and makes it possible to study phase transformations of these compounds using high-temperature powder x-ray diffractometry. Sandwich specimens of sample powder between two sheets of Be foil are clamped between Cu blocks and welded in a He-filled glove box with an inert gas welding unit. Diffractometer patterns obtained for $HoZn_2$ at 25 and 600°C are shown. (Rev. Met. Lit.)

10936 USE OF FACHUCA TANKS IN HYDROMETALLURGY. Josa, J. M.; Merino, J. L.; Gasos, P. Rev. Met. (Madrid), 3: 48-57(Jan.-Feb. 1967). (In Spanish).

The use of this type of reactor in several countries is examined, with particular reference to uranium. A description is given of experimental work carried out in both laboratory and pilot-plant scale using 9-m-high Pachuca tanks to compare their efficiency vs mechanically stirred ones in the leaching of uranium ores. Within the test program various variables are considered, such as acid dose, oxidizer dose, temperature and time of reaction, as well as the effects of grain size, pulp density and sand segregation. Statistical techniques were used in the design and analysis of the experiments. (Rev. Met. Lit.)

10937 READYING THE SWITCH TO ZIRCONIUM. Chem. Weekbl., 100: No. 17, 53-4(Apr. 29, 1967).

A new process for the production of Zr is described. The process will parallel present flow sheets for uranium, using much of the same equipment. Starting with ZrO_2, the operation uses pulsed-column extraction with tributyl phosphate diluted in kerosene as solvent, followed by denitration, reduction and hydrohalogenation. Zr sponge step is bypassed; Zircaloy-2, Zircaloy-4, and Zr–Nb are produced directly in a reduction furnace. Ingots can be converted into billets by consumable arc melting. A study is underway for starting process with zircon sand ($ZrSiO_4$). (Rev. Met. Lit.)

10938 CLEAN, FAST VACUUM BRAZING JOINS DIVERSE MATERIALS. Schwartz, Mel M. Mater. Eng., 66: 76-8(Dec. 1967).

Vacuum brazing produces clean and strong joints in many similar and dissimilar metals and nonmetals. Although used mainly to join aerospace structures, vacuum brazing is now ready for commercial uses, notably for auto radiators, chemical processing equipment and hospital and laboratory hardware. (auth)

10939 IMPROVEMENTS IN OR RELATING TO ASSEMBLIES OF NONDEFORMABLE ELONGATED BODIES. Allsopp, Peter James (to United Kingdom Atomic Energy Authority). British Patent 1,090,535. Nov. 8, 1967. Filed Sept. 29, 1964.

An assembly of corrugated, or otherwise shaped, stainless steel strips arranged in groups is shown in which the strip members of each group are parallel to each other and substantially in a common plane transverse to the parallel axes of the reactor fuel elements. The design locks the fuel rods in place and distributes stresses over the whole of the assembly. Any number of the groups may be used in an assembly as desired but it is preferred to use groups of three forming 60° cells in a honeycomb configuration and a triangular lattice. (P.G.C.)

10940 METHOD FOR TREATING SURFACES OF ZIRCONIUM ALLOY MEMBERS. (to Westinghouse Electric Corp.). British Patent 1,089,610. Nov. 1, 1967. Priority date Oct. 7, 1965, United States.

Acid pickling of Zircaloy tubing, used in nuclear reactors, is eliminated by a process which comprises mechanically removing surface contaminants by a moving abrasive belt, or turning in a lathe, cleaning with an alcohol to remove grit, and burnishing the abraded tube with rolls. The method provides a smooth surface, free from pits which might hold reactive chemical substances, and is corrosion resistant. (P.G.C.)

10941 HEAT TREATMENT OF PLUTONIUM. (to U. S. Atomic Energy Commission). British Patent 1,092,896. Nov. 29, 1967. Priority date Feb. 12, 1965, United States.

A method for treating Pu metal reactor fuel to provide for high density and freedom from cracks comprises casting the molten Pu into the desired shape, cooling to between 95 and 110°C, quenching in a liquid bath at –75 to –115°C to transform the crystals from the beta-phase structure to alpha-phase crystals, and subsequently thermal cycling at –80 to 100°C. (P.G.C.)

Properties Evaluations

Refer also to abstracts 10497, 10500, 10503, 10524, 10924, 12006, and 12034.

10942 (AGN–8249) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, July 1–September 30, 1967. Achener, P. Y. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Nov. 1967. Contract AT(04-3)-368. 25p. Dep. CFSTI.

Experimental runs of the thermal conductivity of cesium vapor were obtained at 1000 to 1300°F. A weld failure at a thermocouple necessitated a shutdown. The refractory metal wire holder of the vapor viscosity apparatus is completed. The determination of the liquid viscosity and liquid specific heat of lithium and sodium as well as the vapor pressure of lithium are completed. The program to determine surface tension, contact angle, and liquid thermal conductivity of lithium and sodium has begun. Results of the determination of surface tension and contact angle of lithium with 1040 ppM nitrogen are reported. Nitrogen concentration in lithium was increased by the addition of lithium nitride. The results are tabulated. (J.C.W.)

10943 (CEA-R-3183) RESONANCE PARAMAGNETIQUE DU GRAPHITE IRRADIE AUX NEUTRONS. VARIATION EN FONCTION DE LA TEMPERATURE ET EXPERIENCES DE RECUIT. (Electron Spin Resonance in Neutron-Irradiated Graphite. Dependence on Temperature; Effect of Annealing). Kester, Tilo (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sept. 1967. 65p. (In French). Dep.

Thesis.

The temperature dependence of the electron spin resonance signal from neutron irradiated graphite has been studied. The results lead to an interpretation of the nature of the paramagnetic centers created by irradiation. In annealing experiments on graphite samples, which had been irradiated at low temperature, two annealing peaks and one anti-annealing peak were found. Interpretations are proposed for these peaks. (auth)

10944 (COO–1477-9) DEVELOPMENT OF TEST PROCEDURES. FRACTURE TOUGHNESS OF REACTOR PRES-

SURE VESSEL STEELS. Period Covered: August 1, 1967–October 31, 1967. Ripling, E. J.; Crosley, P. B. (Materials Research Lab., Inc., Glenwood, Ill.). Dec. 8, 1967. Contract AT(11-1)-1477. 24p. Dep. CFSTI.

A four-inch thick plate of A302-B steel was used for testing tensile properties. Testing was limited to a single location in the plate. Yield stress measurements at 70, 0, and −70°F are summarized. The reciprocal loading time is used as the measure of strain rate. (J.C.W.)

10945 (EUR-3653) LIQUID METALS FOR HEAT-PIPES, PROPERTIES, PLOTS, AND DATA SHEETS. Schins, H. E. J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Sept. 8, 1967. 116p. Dep.

Calculation of the heat transfer in a heat-pipe requires many liquid and vapor data of the working fluid (metal) in the region of the boiling point. Measurements were made for the twelve most current metals of the vapor pressure and the surface tension. For calcium, strontium and barium density measurements were also made. The vapor pressure measurements were made with the new method of Bohdansky, using the heat-pipe effect in an open tube. Surface tension and density measurements were made by the maximum bubble pressure method. The vapor pressure measurements make it possible to evaluate the boiling point, the heat of vaporization and the vapor density. Data sheets are presented for surface tension, vapor pressure, and vapor density. Data sheets for density, viscosity, and vapor viscosity are also presented. (auth)

10946 (NAA-SR-Memo-12590) COMPUTED STRESS: RELAXATION CURVES FOR HASTELLOY ALLOY N. Dalcher, A. W. (Atomics International, Canoga Park, Calif.). Nov. 1, 1967. 35p. Dep. CFSTI.

Creep and stress-relaxation relations were used to provide, analytically, stress-relaxation curves for Hastelloy-N material at various temperatures. The calculated results were compared with test data, where available, and found to be in good agreement. The computed relaxation curves provide information useful for design and analysis at temperatures for which there is no experimental data. The computer program developed for this effort is applicable to other materials which follow the creep rate relation, $\dot{\epsilon} = k\sigma^n$. (auth)

10947 (NP-17211) STUDY OF AS-ROLLED CARBON STEELS OVER RANGES OF URANIUM, SULPHUR, AND CARBON CONTENTS. Faurschou, D. K. (Department of Mines and Technical Surveys (Canada). Mines Branch). May 1966. 54p. (R-178). Dep. CFSTI. CAN $1.00.

Studies of uranium in carbon steels were complemented and clarified by statistically designed and analyzed studies. The results indicate that uranium has a very limited potential usefulness as an alloying element in ferrous metallurgy. Uranium has more potential as a scavenger and sulfide former. A factorial set of as-rolled carbon steels having four uranium levels (nil, 0.15, 0.3, and 0.6%), three sulfur levels (0.006, 0.030, and 0.14%) and two carbon levels (0.14 and 0.34%) was tested to assess the influence of uranium on impact characteristics, active-state corrosion resistance, stress-corrosion resistance, machinability, microstructure, and isothermal transformation of austenite. The sulfur and carbon levels were introduced in anticipation of interaction effects with uranium as well as for hidden replication. Uranium was always detrimental in progressively raising C_v fracture-appearance transition temperatures. However, only uranium contents exceeding 0.15% were inherently detrimental to absorption of impact energy. At the highest sulfur level, and particularly in transverse tests, uranium beneficially raised the curves of C_v impact energy versus temperature. The rates of active corrosion in 5% HCl and H_2SO_4 were significantly but marginally reduced by uranium. Accelerated stress-corrosion results indicated some improvement related to the presence of 0.09% uranium. Uranium in amounts sufficient to globularize sulfides did not significantly affect machinability. Uranium makes possible the production of ultrahigh-sulfur steels having good transverse impact toughness. In carbon steel, uranium refined the as-cast macrostructure, promoted the formation of degenerate pearlite and slightly delayed the transformation of austenite, but had almost no effect on tensile properties. The factorial design of the impact test program permitted quantitative determination of the effects of sulfur and carbon on C_v 15 ft-lb and C_v 50% cleavage transition temperatures. (auth)

10948 (NYO-2731-4) PHASE EQUILIBRIA AND SPECIFIC VOLUMES OF LIQUID METALS AND ALLOYS. Report No. IV. Kanda, Frank A. (Syracuse Univ., N. Y. Dept. of Chemistry). May 1965. Contract AT(30-1)-2731. 51p. Dep. CFSTI.

Liquid state studies concerned with the determination of liquid density isotherms and the utilization of these to delineate the boundaries of immiscibility for systems in which they exist, and to show the existence of compounds in the liquid state are reported. The following systems were studied: Bi–Te, Bi–Mg, Hg–Tl, Mg–Pb, Mg–Sn, and Tl–Se. Magnetic susceptibility studies of the alkali and alkaline earth metals and their alloys are planned. The nature of the allotropy of calcium was studied. (F.S.)

10949 (ORNL-TM-1708) EFFECT OF AGING ON THE CREEP-RUPTURE PROPERTIES OF D-43 WELDS. Stephenson, R. L.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 8p. Dep. CFSTI.

The creep-rupture properties of welds in D-43 (Nb–10% W–1% Zr–0.1% C) were investigated at 1800, 2000, and 2200°F. Aging for times up to 500 hr at 1800°F was found to be detrimental to the short-time creep-rupture properties of the welds. At all other times and temperatures investigated, the weld efficiency was at least 100%. (auth)

10950 (ORO-3091-8) AN INVESTIGATION OF HETEROGENEOUS DISORDERING DURING THE PLASTIC DEFORMATION OF Cu_3Pt. Scardina, Joseph T. (Vanderbilt Univ., Nashville, Tenn.). Aug. 1967. Contract AT(40-1)-3091. 94p. Dep. CFSTI.

Thesis.

A study of a mechanically disordered Cu–Pt alloy indicates that it has a structure different from that of thermally disordered material. It is postulated that the resistivity properties and the thermoelectric behavior of the mechanically disordered specimens might be attributed to a heterogeneous quasi-cell structure consisting of highly disordered and deformed wall segments distributed in a highly ordered relatively undeformed matrix. It was shown that the thermoelectric EMF seemed to have a definite dependence on the difference in degree of order between highly ordered and highly disordered regions. (P.G.C.)

10951 (ORO-3091-9) AN X-RAY DIFFRACTION ANALYSIS OF UNIAXIALLY DEFORMED Cu_3Pt. Buchanan, Raymond Allen (Vanderbilt Univ., Nashville, Tenn.). Aug. 1967. Contract AT(40-1)-3091. 70p. Dep. CFSTI.

Thesis.

Results of a study to determine the overall effect of long-range order on the mechanical properties of a Cu–Pt alloy are reported. It was determined that the degree of long-range order in the thermally ordered alloy decreased with increased tensile deformation as did the effective antiphase domain size. The stress-strain curve for a disordered Cu–Pt alloy specimen indicates that cross-slip occurred during the work hardening stage. (P.G.C.)

10952 (UCRL-17982) THE EFFECT OF TERNARY ADDITIONS ON THE SUPERCONDUCTING PROPERTIES OF Nb_3Al. Hartsough, Larry Dowd (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 25p. Dep. CFSTI.

Thesis.

The J_c vs H characteristics of Nb_3Al, with T_c of 16.8°K, were compared with those of an alloy of nominal composition $Nb_3(Al_{0.8}Ge_{0.2})$, with T_c of 18.7°K. A substantial improvement for the latter was found. The effect on T_c of As additions to Nb_3Al was considered but it was found that the solubility is less than two atomic percent. The recently-reported high T_c (20.05°K) for well-ordered $Nb_3(Al_{0.8}Ge_{0.2})$ leads to the consideration of the effect of Ge additions to Nb_3Al on its upper critical field H_{c2}. A prediction of an increase in H_{c2} was borne out by the results obtained using pulsed magnetic fields. It was predicted that the steady-field J_c vs H properties may show better conductive properties under steady-field conditions. It is contended that the addition of As to Nb_3Al will improve the stoichiometry (hence the T_c) of the latter without affecting its electron/atom ratio or electron density. Unfortunately, the solubility of As in Nb_3Al is too low to test the prediction. (auth)

10953 (ORNL-tr-1790) INVESTIGATION OF THE CREEP AND STRESS-RUPTURE BEHAVIOR OF BINARY AND TERNARY VANADIUM ALLOYS. Bohm, H.; Schirra, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Less-Common Metals, 12: 280-93(1967). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The creep and stress-rupture behavior of binary V–Ti and ternary V–Ti–Nb alloys were studied at 650 to 800°C. A strong influence of the titanium content on the creep and stress-rupture properties was found in the binary alloys as well as in the ternary alloys. At titanium concentrations above 5% the stress-rupture strength is lowered with increasing titanium content, whereas the ultimate tensile strength at the same temperature shows an increase with increasing titanium content. The activation energy for creep of pure vanadium 650 to 800°C corresponds to the activation energy of diffusion; with increasing titanium content of the alloy the activation energy for creep at first decreases and then

increases to more than 100 kcal/g-molecule at a titanium concentration of 20%. The stress exponent for creep at 650°C has a maximum at about 5% titanium. No influence of the niobium content on the activation energy and the stress exponent could be found. All alloys show a transgranular fracture. (auth)

10954 (ORNL-tr-1823) PLASTIC DEFORMATION OF COBALT SINGLE CRYSTALS. Seeger, A.; Kronmueller, H.; Boser, O.; Rapp, M. Translated for Oak Ridge National Lab., Tenn., from Phys. Status Solidi, 3: 1107-25(1963). 28p. Dep. CFSTI. JCL $2.60 fs, $1.07 mf.

Cobalt single crystals were plastically deformed in tension at various temperatures. The ductility of the crystals remained good even at low temperatures. The work-hardening curves and the electron microscopy slip line patterns are qualitatively similar to those of other hexagonal metals and may be similarly interpreted. Besides plastic shear on the basal plane, $\{11\bar{2}2\}$ and $\{11\bar{2}4\}$ twin planes are observed for the investigated crystal orientations. The geometry of this so-called anomalous twin formation is discussed. (auth)

10955 STUDY OF WELD ZONES PRODUCED BY ELECTRON BOMBARDMENT IN U–Mo ALLOYS CONTAINING FROM 0.5 TO 2 WT PERCENT MOLYBDENUM. Sifferlen, R.; Giraud-Heraud, F.; Saulnier, A.; Collot, C.; Auchere, H.; Francois, D. Mem. Sci. Rev. Met., 64: 757-68(Sept. 1967). (In French).

An electron microscope study of U–Mo alloy welds was made. Welds of alloys with Mo concentrations above 1% are brittle. A study of their mechanical behavior in room-temperature tensile tests is reported. (tr-auth)

10956 THE PROPERTIES OF Zr ALLOYS AS CONSTRUCTION MATERIALS IN NUCLEAR REACTORS. PART II. Wiedemann, K. H. (Institut fuer Reaktorforschung, Wurenlingen, Switzerland). Metall, 21: 1042-7(Oct. 1967). (In German).

The creep behavior of Zr alloys was analyzed. The two most important parameter equations for interpolation and extrapolation of known measurement values were derived. The extrapolation of the time behavior using the Larson-Miller parameters is described. (J.S.R.)

10957 THE SELF-DIFFUSION OF OXYGEN IN MAGNETITE. TECHNIQUES FOR SAMPLING AND ISOTOPIC ANALYSIS OF MICRO QUANTITIES OF WATER. Castle, J. E.; Surman, P. L. (Central Electricity Research Lab., Surrey, Eng.). J. Phys. Chem., 71: 4255-9(Dec. 1967).

A new technique for the sampling and isotopic analysis of micro quantities of water is described. The method was applied to the investigation of oxygen self-diffusion in magnetite using a continuous sampling method. The self-diffusion coefficient of oxygen in magnetite over the temperature range 302 to 550° can be expressed as: $D = 3.2\ (\pm 1.6) \times 10^{-14} \exp[(-17{,}000 \pm 1650)/RT]$. The very small value for D makes it unlikely that oxygen solid-state diffusion is a rate-controlling step in the corrosion of mild steel by water or steam. (auth)

10958 SOME GERMANIDES OF RARE-EARTH METALS. Lynchak, K. A.; Kosolapova, T. Ya. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 92-6(Nov. 1967). (In Russian).

The conditions for obtaining the germanide phases — Me_5Ge_3, MeGe, and $MeGe_2$ for lanthanum, cerium, praseodymium, and neodymium by means of arc melting in argon medium were investigated. Optimum ratio of starting components is determined. For obtaining the lanthanum, cerium, and praseodymium digermanides it is necessary to have 1% of germanium surplus in the starting mixture; for obtaining the neodymium germanides Nd_5Ge_3 and $NdGe_2$ it is necessary to lack 1 to 3% and for NdGe – 1 to 5% of germanium. (auth)

10959 ELASTICITY MODULUS OF Nb–Ti ALLOYS WITH V, W, AND Cr ADMIXTURES. Nedyukha, I. M.; Chernyi, V. G. Izv. Akad. Nauk SSSR, Metal., No. 6, 210-12(Nov.-Dec. 1967). (In Russian).

The influence of V, W, and Cr on the elasticity modulus of Nb alloys was studied using Nb – 20% Ti, Nb – 20% Ti – V(W, Cr) and ternary alloys containing 5, 10, 15, and 20% W, V, and Cr. (R.V.J.)

10960 STUDIES OF PHYSICAL PROPERTIES AND HEAT RESISTANCE OF CONTINUOUS SOLID SOLUTIONS OF Ti–Zr AND Ti–Hf. Nartova, T. T.; Andreev, O. N. Izv. Akad. Nauk SSSR, Metal., No. 6, 180-5(Nov.-Dec. 1967). (In Russian).

Specific electric conductivity, hardness, modulus of normal ductility, microstructure, and heat resistance of binary alloys of Ti–Zr, Ti–Hf containing up to 40% Zr and Hf were studied. Constitution diagrams of Ti–Zr and Ti–Hf alloys were constructed at temperatures up to 1500°C. (R.V.J.)

10961 HIGH TEMPERATURE EMITTANCE OF COATED REFRACTORY METAL. Allen, T. H.; Johnson, C. R.; Rusert, E. L. (McDonnell Co., St. Louis). pp 111-23 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

The thermal emittance of coated refractory metals was measured at 1600 to 3200°F. Total normal emittance was measured with a high-temperature emissometer. The investigation was conducted to determine emittance values for design purposes and to study compatibility and degradation of coated refractory metals subjected to a re-entry time-temperature-pressure profile. The precision and accuracy of the measurements were experimentally analyzed by measuring the total normal emittance of graphite, polished tungsten, aluminum oxide, and oxidized Inconel and comparing the results with other published data. The emissometer design incorporated an inductively heated specimen housed in a quartz chamber with water-cooled end fittings and controlled air flow capabilities. Measurements were made under reduced pressures. Emittance measurements were made by comparing the radiation emitted by the specimen with that from a calculated reference cavity embedded in the front face of the specimen. The complete optical transfer system and associated instrumentation are presented in detail. Some emittance measurements were made during gradual heating and cooling cycles while others were made during the cooling cycle (decreasing temperature) after having rapidly heated the sample to a desired peak temperature according to the time-temperature-pressure profile. The emittances of siliconized molybdenum (McDonnell's L-7 and Chromalloy's W-3), siliconized tungsten (McDonnell's L-7 and Chromalloy's W-X), siliconized niobium (McDonnell's TS-137 and Sylcor's R512A), and aluminized niobium (McDonnell's LB-2) are presented. (auth)

10962 EFFECTS OF HYDROGEN TREATMENT ON THE DUCTILITY OF MOLYBDENUM UNDER 760 and 10^{-10} TORR. Feuerstein, Seymour (Aerospace Corp., El Segundo, Calif.). pp 299-306 of The Effects of the Space Environment of Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19-21, 1967. See CONF-670435.

Room-temperature tensile experiments on polycrystalline molybdenum indicated a grain size and heat treatment contribution to the difference in strain-to-fracture of specimens deformed at 760 Torr to those deformed at 10^{-10} Torr. The magnitude of the effect appeared to depend critically on grain size and impurity distributions resulting from heat treatment with and without a hydrogen atmosphere. However, it was determined that the ductility effects are predominantly due to a change in ductility of specimens tested at atmospheric pressure. Ultrahigh vacuum tensile behaviors are relatively unaffected. The largest difference in strain-to-fracture (~13%) was in a narrow grain-size range in which specimens were first recrystallized and then soaked in a hydrogen atmosphere. The enhancement of ductility of hydrogen-treated specimens under vacuum suggests the involvement of a hydrogen-related gaseous contaminant. (auth)

10963 PROPERTIES OF VAPOR-DEPOSITED URANIUM FILMS IN ULTRAHIGH VACUUM AND IN HYDROGEN. Hopkins, B. J.; Sargood, A. J. (Southampton Univ., Eng.). Nuovo Cim., Suppl. (1), 5: 459-65(1967).

From International Symposium on Sorption–Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

In order to clarify results of earlier studies on the changes in the work function that have been observed in thin films of uranium deposited on polycrystalline tungsten foil as the temperature of the latter is cycled through the two crystallographic phase changes of bulk uranium, the surface potential of hydrogen, which is the predominant gas during evaporation, on the uranium film was studied. The Zisman modification of the Kelvin contact potential difference (CPD) method was used. The measured surface potentials could explain the high CPD's (~1.4 V) which have been previously observed. Results were checked by the determination of the surface potential of hydrogen by a retarded potential technique. (J.G.B.)

10964 SURFACE POTENTIAL OF HYDROGEN ON URANIUM. Riviere, J. C. (Atomic Energy Research Establishment, Harwell, Eng.). Nuovo Cim., Suppl. (1), 5: 466-71(1967).

From International Symposium on Sorption–Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

The surface potential of hydrogen on a vacuum-deposited uranium film was found to be negative at all stages of various constant rates of hydrogen admission. The potential reached a maximum value of –1.06 eV. An explanation for the relatively high potential is offered. (J.G.B.)

10965 THERMODYNAMIC PROPERTIES OF HYDROGEN AND DEUTERIUM IN α-TITANIUM. Giorgi, T. A. (SAES GETTERS Research Labs., Milan); Ricca, F. Nuovo Cim., Suppl. (1), 5: 472-82(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

Thermodynamic properties of hydrogen and deuterium in α-Ti were studied using experimental techniques which permitted measurements at very low concentrations and in a wide pressure and temperature range. Results indicated that both hydrogen and deuterium solutions in α-Ti followed Sievert's law in the explored concentration range. Very small differences were found to exist between the relative partial molal enthalpies for the two gases, as well as between the constant term in their partial molal entropies. The partial molal entropies of the dissolved species, however, were appreciably greater for deuterium than for hydrogen. The extremely low values of the calculated vibration frequencies and Einstein temperatures, as well as their strong dependence on temperature, indicated the nonapplicability of the model of Gulbransen and Andrew. Results were compared with previously reported data on similar experiments with zirconium. (J.G.B.)

10966 INVESTIGATIONS INTO THE MECHANISM OF TRAPPING OF INERT GAS IONS IN POLYCRYSTALLINE TUNGSTEN. Erents, K.; Carter, G. (Univ. of Liverpool). Vacuum, 17: 215-18(Apr. 1967).

Trapping inert gas ions injected into polycrystalline was studied by successive bombardment of W with 2 different ion species and observation of the desorption spectra. The ions were accelerated towards a polycrystalline W ribbon target, at energies between 100 eV and 2 keV, into which a proportion was trapped. Thermal desorption was carried out in a closed volume by application of a current-time function to the target which produced a linear rise in the target temperature. In a study of the influence of prior bombardment of the W surface by Kr^+ on low-energy He^+ trapping, a dose of 1.5×10^{14} ion/cm^2 140-eV He^+ was employed. A series of He desorption spectra was obtained for initial 500-eV Kr^+ bombardments. A rapid increase in He^+ trapping occurred as the initial Kr ion dose increased. The Kr itself could be trapped in 3 types of sites (with most probable energies of 2.1, 3.1, and 5.1 eV). In addition the He^+ injected into the Kr-bombarded target could enter 2.1 and 3.1 eV sites, but not 5.1 eV sites. To examine the nature of higher energy sites in W, changes in the primary gas desorption spectra were studied. The spectra for 500-eV Ne^+, initially trapped at a target temperature of 1000°K, are shown for no secondary Xe^+ bombardment, and with a post bombardment with 500-eV Xe^+. No Ne release occurred until after 1000°K. The single peak observed was associated with an activation energy of 3.1 eV. The 500-eV Xe^+ could reach such sites, since desorption spectra for it alone showed trapping associated with activation energies of 2.1 and 3.1 eV. The results indicated that higher energy primary ions produce damage sites with a spectrum of activation energies for trapped He gas release, those with lower activation energies being only partially filled by the primary gas. Gas release is conditioned mainly by the W rather than the gas species, so that activation energies can be assigned to different damage sites. High energy ions produce damage sites associated with high activation energies for gas release, in preference to producing the lower energy damage sites. (BBB)

10967 DIFFUSION OF PALLADIUM, SILVER, CADMIUM, INDIUM, AND TIN IN ALUMINUM. Anand, M. S.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay). Trans. Met. Soc. AIME, 239: 1848-53(Nov. 1967).

Using residual activity technique, the diffusion of palladium, silver, cadmium, indium, and tin in aluminum has been studied at 400 to 630°C. The diffusivities (in units of square centimeters per second) have been expressed as: $D_{Pd/Al} = (1.92 \pm 0.32)10^{-7}$ exp [–(20,200 ± 162/RT)], $D_{Ag/Al} = (0.21 \pm 0.04)$ exp [–(29,000 ± 348/RT)], $D_{Cd/Al} = (7.94 \pm 1.31)10^{-8}$ exp [–(21,700 ± 175/RT)], $D_{In/Al} = (1.42 \pm 0.22)10^{-8}$ exp [–(22,200 ± 177/RT)], and $D_{Sn/Al} = (3.05 \pm 0.50)10^{-7}$ exp [–(20,200 ± 200/RT)]. The results are discussed on the basis of structural changes produced owing to the presence of these solutes in the host lattice and their solid solubilities in the parent matrix. An attempt has also been made to apply the existing theories of charge and size difference between the solute and the solvent to get better insight into the diffusion mechanism of the low solid solubility diffusing species in aluminum. (auth)

10968 FRICTION CONDITIONS IN A MASS OF METAL POWDER. Hausner, Henry H. (Polytechnic Inst. of Brooklyn, Univ. of California, Los Angeles). Int. J. Powder Met., 3: No. 4, 7-13(Oct. 1967).

The density of a loose metal powder depends on a number of powder characteristics, which together determine the friction conditions in a mass of powder. A factor connected with the friction conditions in a metal powder is an important characteristic of the powder, and of value in the prediction of powder behavior during processing. (auth)

10969 RESEARCH ON THE MECHANICAL ANISOTROPY OF ZIRCALOY-2. Hosford, W. F. (Univ. of Michigan, Ann Arbor); Rittenhouse, P. L.; Picklesimer, M. L. Electrochem. Technol., 5: 554-5(Nov.-Dec. 1967).

Approximate yield loci for Zircaloy-2 plates were constructed from tensile and compression data. Reasons for the high values of compressive yield stress are discussed. (M.C.G.)

10970 SOME PROPERTIES OF FLOATING ZONE MELTED Mo, W AND Ta. PT. 7. THE ELECTRON BEAM MELTING OF REFRACTORY METALS. Nippon Kinzoku Gakkaishi, 30: 1022-6(1966).

The refining effects of floating zone melting on Mo, W, and Ta were investigated from their mechanical properties and chemical analysis. Floating zone melted W and Mo rods showed excellent ductility at room temperature. By the floating zone melting method, W and Mo grew to single crystals rather easily and their crystal orientations were almost near the (111) direction. By tensile tests, zone melted Mo and Ta rods showed fractures of the chisel-type break pattern and no yielding was observed. Compression strain hardening exponents of the floating zone melted Mo and W rods were smaller than those of the starting materials, but in the case of the Ta rod, the strain hardening exponent of the zone melted part was somewhat larger than that of the starting rod. The resistance ratio of the zone melted Mo rod was 2.8×10^{-4} against 4.0×10^{-2} in the starting rod and 3.2×10^{-2} in the recrystallization zone. (Rev. Met. Lit.)

10971 STRUCTURE AND MAGNETIC PROPERTIES OF Co–W AND Co–Mo ALLOYS. Henke, Joachim; Henkel, Otto. Neue Huette, 12: 240-1(Apr. 1967). (In German).

The suitability of Co–W and Co–Mo alloys as permanent magnets is considered. The structure of hypoeutectic, eutectic and Co_3W stoichiometric Co–W alloys at various temperatures, along with coercive force and residual magnetism vs tempering temperature curves are given. These properties are compared with the eutectic alloys of both Co–W and Co–Mo, the former showing a higher maximum residual magnetism. (Rev. Met. Lit.)

10972 PLASTICITY OF PURE NIOBIUM SINGLE CRYSTALS. Duesbery, M. S.; Foxall, R. A.; Hirsch, P. B. J. Phys. (Paris), Suppl, 27: No. 7-8, 193-204(July-Aug. 1966).

Purification of Nb single crystals by annealing in ultrahigh vacuum reduces the critical resolved shear stress to 600 g/mm^2 at 295°K at a strain rate of 1.3×10^4/sec. The stress-strain curves of these crystals have three stages of hardening similar to those of fcc metals. The slip lines in the early stages of deformation are wavy on the top face and straight on the side face suggesting that the edge dislocations travel much farther than the screws and that slip bands are formed by the double cross-slip mechanism. Stage II of the stress-strain curve is characterized by the appearance of bands of secondary slip, rather similar to the case for fcc crystals. The rapid hardening rate is likely to be due to interactions between primary and secondary dislocations. Slip occurs either on {011} or {121} planes depending on the orientation of the crystal. The results on the orientation dependence of the operating slip planes show that the critical resolved shear-stress on (001), (121) in tension and (121) in compression are all different from each other. These results indicate that the lattice friction stresses for these modes of slip differ from each other and that there is also an orientation dependent contribution to the flow stress. The asymmetry for slip on {121} planes is explained in terms of the 3-fold dissociation of screw dislocations. 19 ref. (Rev. Met. Lit.)

10973 METHOD OF TENSILE TESTING OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS. Peakarev, A. I.; Gartman, M. V.; Chistyakov, Yu. D. Ind. Lab. (USSR) (Engl. Transl.), 32: 278-80(1966).

Tensile specimens of W and Mo can be prepared from single crystals in a device in which the rotating single crystal is electrically polished by a cathode template in the shape of a polished disk. The number of specimens which can be made from the rod is determined by the length of the single crystal. Electrolytes are 5% caustic soda and 10% sulfuric acid in methyl alcohol for W and Mo, respectively. A grip to hold the specimens has been designed in which the end of the specimen is held between two plates pressed together by screws. (Rev. Met. Lit.)

10974 ABOUT THE EFFECT OF SURFACE GAS ON ANALYTICAL DETERMINATION OF GAS CONTENT IN Mo AND W. Friedrich, K.; Barthel, J.; Kunze, J. (Institut fuer

Metallphysik und Reinstmetalle, Dresden). J. Less-Common Metals, 14: 55-68(1968). (In German).

Gas determinations, carried out by vacuum-degassing procedures, with zone-melted single-crystalline tungsten and molybdenum, show that the oxygen, nitrogen and hydrogen contents of etched crystals increase with the surface-to-mass ratio. This result indicates that concentrations determined by analysis are decisively influenced by surface gases. This effect was most marked with oxygen. On etched tungsten samples the oxygen surface concentration amounted to 2 $\mu g/cm^2$ geometrical surface. A short annealing at 800°C in a hydrogen stream decreased the amount of surface gas without removing it completely. The residual oxygen surface content on tungsten was estimated to be I $\mu g/cm^2$, which can be explained by a chemisorption layer of atomic dimension. The volume concentration of oxygen could be estimated by extrapolating the analytically determined content to zero surface area. In this way the volume content was found to lie at or below 0.5 ppM O_2 in tungsten single crystals which showed 2 to 3 ppM O_2 by analysis. (auth)

10975 YIELDING AND FRACTURE OF Fe–30 PERCENT Cr ALLOYS SUBJECTED TO 475°C EMBRITTLEMENT. Lagneborg, R. (Aktiebolaget Atomenergi, Stockholm). Acta Polytech. Scand., Chem. Met. Ser., No. 62: 40p.(1967).

Embrittlement at 475°C was studied in two Fe–Cr alloys, one Fe–30% Cr and one Fe–30% Cr–0.8% Ti alloy. Yield and fracture stress were determined at room temperature for various grain sizes and after aging at 475°C for periods up to 1,000 hr. The fracture stress $d^{0.5}$ curve, where d is the grain diameter, displays a characteristic bend. The curve has one branch with a large slope and approximately extrapolating to a zero stress intercept for large grain sizes, and one branch with a more moderate grain size dependence for small grain sizes. In the embrittled material cracks were observed to be initiated by twins. An expression for the fracture stress was derived for the case when cracks are initiated by twinning. The derivation was based on the theory of brittle fracture by Cottrell. The equation is suggested to account for the experimental fracture stresses at large grain sizes. The ultimate cause for the brittleness is the age hardening owing to the fine precipitation taking place at 475°C. The rise in yield stress will promote brittleness directly, but also indirectly through the enhanced twinning which will increase the tendency for crack initiation. (auth)

10976 A PRELIMINARY STUDY OF VAPOR DEPOSITION OF RHENIUM AND RHENIUM–TUNGSTEN. Donaldson, J. G.; Hoertel, F. W.; Cochran, A. A. (Rolla Metallurgy Research Center, Mo.). J. Less-Common Metals, 14: 93-101(1968).

Coherent, high-purity rhenium deposits were obtained by the hydrogen reduction of ReF_6 from the vapor phase, although rhenium powder was always produced. The reaction temperature and the ratio of H_2 to ReF_6 significantly influenced the amount of coherent rhenium deposited. The near-optimum parameters are temperature, 250°C; H_2 to ReF_6 gas volume ratio, 25. The deposition efficiency for coherent rhenium deposits was 70 to 75%. The average Knoop microhardness of vapor-deposited rhenium was 907, measured under a 100 g load. Intermittent deposition is undesirable for forming coherent deposits because it produces discontinuities in the metal. Codeposits of rhenium and tungsten were obtained, but they were of nonuniform composition, owing to the large difference in optimum reduction temperatures of their hexafluorides. (auth)

10977 DIFFUSION OF VANADIUM IN NIOBIUM, ZIRCONIUM, AND VANADIUM. Agarwala, R. P.; Murarka, S. P.; Anand, M. S. (Bhabha Atomic Research Centre, Trombay, India). Acta Met., 16: 61-7(Jan. 1968).

Diffusion of vanadium in niobium, zirconium, and vanadium crystals was studied using radioactive tracer and residual activity technique. Characteristic plots for the diffusion of vanadium in niobium, zirconium, and vanadium are shown. The temperature dependence of diffusivity of vanadium in niobium, zirconium, and vanadium are graphically represented. (J.C.W.)

10978 POWDER METALLURGY. Joyce, N. N. DMIC Review of Recent Developments, July 5, 1967. Columbus, Ohio, Battelle Memorial Inst., 1967. 6p.

Development of an improved manufacturing process for the production of higher purity superalloy powders is underway. The two superalloy compositions chosen were Udimet 700 and B-1900. Goals were an O_2 content of 0.03% maximum (300 ppM), impurity content, 0.05% maximum, useful powder yield, 70% (–40 mesh). Powder properties of B-1900 alloy are stated. A program has been initiated for the development of a manufacturing process for the precision forging of powder metallurgy preforms. The program is designed to produce forged gas-turbine components from such alloys as B-1900, MAR-M-200, TD-Ni-high thoria, and TD-Ni-Cr. Four alloy powders, U-700, IN-100, Waspaloy, and X-40, were used to evaluate the practicability of developing a manufacturing process for the continuous production of metal strip and sheet by the slip casting process. A survey of literature on methods of determining the particle size of fine powders was performed. The survey was limited to measurement in the subsieve range. The feasibility of high-energy rate compaction as a means of consolidating powder blends used in the preparation of dispersion-strengthened alloys is explored. Studies on the production of ultrafine Be powder by the electrolysis of a molten $BeCl_2$–NaCl mixture using a Hg cathode were continued. Other programs involve strengthening of Cr composites by alloying, strengthening Co alloys with fine ThO_2 dispersions, and dispersion-strengthened Ni alloys. A listing of 15 references is included. (Rev. Met. Lit.)

10979 HAFNIUM ALLOYS. Morton, Peter Harlow; Clark, Peter Vincent McDonald (to Imperial Metal Industries (Kynoch) Ltd.). British Patent 1,095,925. Dec. 20, 1967. Filed Dec. 2, 1965.

Hafnium-base alloys consisting of one or both of the beta stabilizing elements; 5 to 30% Zr and 15 to 30% Nb, 0 to 2% total of one or more of the beta stabilizing elements Cr, Fe, Mo, and Ni, 0 to 5% of the beta stabilizing Si, 0 to 2% of one or both of the alpha stabilizing elements. Al and Sn were prepared and the corrosion resistance and tensile properties determined. The beta stabilizing elements strengthen Hf. The alpha stabilizing elements have little effect on strength when added alone but improve the properties of the beta stabilized alloy, Niobium and Zr improve strength but reduce neutron absorption. Corrosion resistance depends on the alloying elements added and the amount present. (F.S.)

10980 STRUCTURAL AND MAGNETIC PROPERTIES OF $TiCr_2$, $ZrCr_2$, $HfCr_2$, AND THE YFe_2–YCo_2 AND $TiCo_2$–$ZrCo_2$ ALLOY SYSTEMS. Abel, Alan Wilson. Pittsburgh, Univ. of Pittsburgh, 1967. 85p.

Thesis.

Structural and magnetic properties of the polymorphic chromium Laves phases $TiCr_2$, $ZrCr_2$, $HfCr_2$, and the pseudobinary Laves phase systems YFe_2–YCo_2 and $TiCo_2$–$ZrCo_2$ were investigated. Lattice parameters and values of the appropriate magnetic quantities as functions of temperature and field strength are reported for each sample in all systems. Saturation moments are reported for each sample in the YFe_2–YCo_2 system. The results in the chromium and $TiCo_2$–$ZrCo_2$ systems were interpreted as indicating that Ti, Zr, and Hf have the same relative valency in these systems. The results in the YFe_2–YCo_2 system were interpreted as indicating a constant degree of electron transfer from the yttrium to the B component in the 0-80% Co region, and a much greater degree of transfer in the cobalt rich region. (Disser. Abstr.)

10981 GUIDE TO UNCOMMON METALS. Simons, Eric N. New York, Hart Publishing Co., Inc., 1967. 253p. $12.00.

The classification, origin of the name, history, principal ores and sources of supply, methods of extraction and production, and the properties of 46 uncommon metals are discussed. The metals omitted are ones of which vast material has been published or are the noble metals. (J.C.W.)

10982 BEHAVIOR OF MATERIALS AT CRYOGENIC TEMPERATURES. A Symposium Presented at the Sixty-Eighth Annual Meeting, American Society for Testing and Materials, Lafayette, Ind., June 13–18, 1965. Amer. Soc. Test. Mater., Spec. Tech. Publ., No. 387, 1-148(1966). (CONF-650646).

Four papers and one abstract of a previously published paper are presented on various aspects of the behavior of materials at cryogenic temperatures. The papers include the following subjects: engineering considerations regarding the fracture of metals at cryogenic temperatures, low-temperature phase transformations, effect of metallurgical variables on the superconducting properties of metals and alloys, and thermophysical properties of metals at cryogenic temperatures. (J.H.M.)

Structure and Phase Studies

Refer also to abstracts 10924, 10948, and 10958.

10983 (COO–1676-1) DISLOCATION-SOLUTE ATOM INTERACTIONS IN ALLOYS. Progress Report, February 1, 1967–January 31, 1968. Gibala, R.; Povolo, F.; Ulitchny, M. G.; Ravi, K. V. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy). Oct. 31, 1967. Contract AT(11-1)-1676. 18p. Dep. CFSTI.

Results of research on the dislocation-solute atom interactions in Fe–Ni alloys are summarized. It is established that substitutional solutes have only minor effects on the dislocation damping in bcc refractory metals, even after extended purification, compared

with the residual interstitials. It was also determined that amplitude damping may be accurately described by a linear equation, Q_H^{-1} is proportional to ϵ_0, that a linear dependence of damping on strain amplitude best characterizes the results obtained on Nb and some of its dilute substitutional alloys, and that temperature dependence of the amplitude damping shows the effect of at least two stages of pinning at 23 to 800°C. Effects of dislocation damping on zone-melted Nb and Nb-base alloys are diagrammed. (P.G.C.)

10984 (COO-1676-3) INTERSTITIAL ALLOYS OF BCC METALS. Gibala, R. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Metallurgy); Wert, C. A. (Illinois Univ., Urbana. Dept. of Mining, Metallurgy, and Petroleum Engineering). Oct. 31, 1967. Contract AT(11-1)-1676. 140p. Dep. CFSTI.

A description of the geometry of bcc interstitial alloys is given. A statement of the thermodynamics and experimental studies of the metal-gas systems is included. Internal friction and diffusion of the interstitials are discussed. Interstitial-interstitial and interstitial-dislocation interactions are developed. A listing of 186 references is included. (J.C.W.)

10985 (ORO-3091-7) DEFORMATION STUDIES OF SUPERLATTICE STRUCTURES. Progress Report, December 1, 1966 to November 30, 1967. Wert, James J.; Cupschalk, Stephen G. (Vanderbilt Univ., Nashville, Tenn.). Dec. 1, 1967. Contract AT(40-1)-3091. 5p. Dep. CFSTI.

Progress on studies of the effects of deformation Cu-Pt, and Fe-Al superlattice alloys is reported. (P.G.C.)

10986 (JPRS-43479) BERYLLIDES. Samsonov, Grigoriy Valentinovich. Translated from pp 1-106 of Berillidy, Kiev, 1966. 98p. CFSTI.

Data on phase diagrams of the elements of the periodic system in combination with beryllium, on methods of beryllide synthesis, on beryllide structure, properties, and areas of application; and information on beryllium and complex beryllides are summarized. The electronic structure and physicochemical properties of beryllides are discussed. A listing of 270 references is included. (auth)

10987 (UCRL-Trans-10186) COMPACTING OF POWDERS. Vergnon, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by B. Harocopos for Univ. of California Lawrence Radiation Lab., Livermore, from report CEA-Bib-70. 34p. Dep. CFSTI. JCL $3.60 fs, $1.25 mf.

Several mechanisms can be invoked to explain the variation of the volume of a powder when it is compacted, notably the pressing into contact of the particles, their sliding over one another, their elastic or plastic deformation, and their fragmentation. Several equations have been proposed to connect the apparent volume of a compact with the applied pressure. The experimental verification of these equations has generally involved compacting of the powders whose particles have been relatively coarse (of dimensions greater than a micron). However, study of the compacting of alumina microspheres has shown that the most generally accepted equations did not accurately portray the results obtained, except for Kawakita's equation. It is concluded that during compacting alumina microspheres behave like infinitely hard particles, and that (for pressure less than 4 tons/cm^2) they do not undergo any appreciable fragmentation or plastic deformation. In addition, it was also demonstrated that the coefficient of friction depended on the particle size. (J.C.W.)

10988 DISTRIBUTION OF COHERENT PARTICLES IN NICKEL ALLOYS. Hornbogen, Erhard; Roth, Martin (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 842-55(Dec. 1967). (In German).

Growth, distribution and shape of the γ'-particles as well as the influence of dislocations on their formation were investigated for nickel alloys with additions of aluminum, silicon, chromium and aluminum, and beryllium. The combination of bright field and dark field technique of electron transmission microscopy of thin foils proved to be a suitable method for this investigation. The difference in lattice parameter $\epsilon = a_{\gamma'} - a_\gamma / a_\gamma$ [%] between particle and matrix was determined by x-ray analysis. For alloys with $\epsilon \approx 0$ (nickel-chromium-aluminum) growth, shape, and distribution of the γ'-particles may be described according to the theory of C. Wagner for the growth of precipitates from liquids in the case of spheres with homogeneous distribution. For alloys with low values of ϵ (nickel-aluminum, nickel-silicon) a similar law of growth is valid. However, there occur cubes which assemble in rows. In alloys with high values of ϵ ($\epsilon > 3\%$) growth starts immediately in plate-like or rod-like shape. For the alloys two critical particle sizes, d_1 and d_2, are found which characterize the deviation from the statistical distribution of particles. The critical particle sizes depend mainly on ϵ. d_1 (and in analogy d_2) is infinite for $\epsilon < 0.05\%$, and approximately identical with the lattice parameter for $\epsilon > 3\%$. Dislocations may increase or decrease the activation energy of nucleation of γ'. In a certain temperature interval nucleation occurs preferredly on edge dislocations for particles with $\epsilon \neq 0$. For $\epsilon = 0$ the activation energy for the formation of particles is increased in the vicinity of dislocations within the same range of temperatures. At a certain degree of supersaturation particles are formed independently of ϵ in the vicinity of dislocations and in the basic lattice. The arrangement of particles in rows is found inside the spinodal curve as well as outside, if $\epsilon \neq 0$. For its occurrence it is therefore irrelevant whether the beginning of precipitation is due to spinodal segregation or to nucleation. Corresponding processes occur if γ' is metastable. Additionally, however, the formation of the stable phase has to be taken into account, which always occurs in a distribution coarser than γ' does (example: nickel-beryllium). (auth)

10989 SOLUBILITY OF Pu IN Fe. Moreau, G.; Calais, D. (Centre d'Etudes Nucleaires, Fontenay-aus-Roses, France). J. Nucl. Mater., 24: 121-4(1967). (In French).

The solubility of Pu in a-Fe was determined by x-ray microanalysis and the results showed that between 850 and 880°C the solubility is less than 0.1 wt %. PuFe diffusion couples with 4 wt % of Pu-Fe were annealed at 910 to 1,300°C. Above the eutectic point 1165°C the diffusion is produced in the presence of a liquid phase. In the vicinity of the interface it disappears rapidly because the Fe diffuses there very rapidly. In a very short time a zone A is formed which is monophase at the anneal temperature and whose Pu concentration corresponds to the saturation of the γ Fe. This zone separates the pure Fe from the biphase alloy. Below the eutectic point only intergranular diffusion is detected. At an anneal temperature of 1,142°C three zones are shown: pure Fe where the Pu diffuses only in the grain boundaries, zone A saturated in Pu, and a biphase zone. The results of the solubility determinations are tabulated. (J.S.R.)

10990 X-RAY STUDIES OF Al RICH TERNARY Al-Cu-Cr, Al-Cu-Zr, AND Al-Cr-Zr SYSTEMS AND QUATERNARY Al-Cu-Cr-Zr SYSTEMS. Zarechnyuk, O. S.; Malinkovich, A. N.; Lalayan, E. A.; Markiv, V. Ya. Izv. Akad. Nauk SSSR, Metal., No. 6, 201-4(Nov.-Dec. 1967). (In Russian).

Studies of 115 specimens of aluminum rich Al-Cu-Cr, Al-Cu-Zr, and Al-Cr-Zr, and Al-Cu-Cr-Zr alloys showed that in aluminum base solutions the ternary and quaternary phases are absent. Only aluminum-rich compounds (binary $CuAl_2$, $CrAl_3$, and $ZrAl_3$) were found to be in equilibrium with aluminum. (R.V.J.)

10991 CONSTITUTION DIAGRAM OF MOLYBDENUM RICH Mo-Zr-C SYSTEM. Zakharov, A. M.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal., No. 6, 193-200(Nov.-Dec. 1967). (In Russian).

Molybdenum angle in the ternary Mo-Zr-C system was studied and solid state diffusion of Zr and C into Mo was analyzed with alloys containing from 0 to 0.5% C and from 0 to 6% Zr. Microscopic, structure, and phase analyses were made and the melting point for ternary Mo-Zr-C system was found at 2260°C. (R.V.J.)

10992 CONSTITUTION DIAGRAMS OF Th-Tb AND Th-Ho ALLOYS. Badaeva, T. A.; Kuznetsova, R. I. Izv. Akad. Nauk SSSR, Metal., No. 6, 186-92(Nov.-Dec. 1967). (In Russian).

Microstructure, thermal, hardness and x-ray analyses were made of Th-Tb and Th-Ho alloys and constitution diagrams for the alloy were constructed. A peritectoid character of transformations was observed in solid state reactions: $\beta_{Th\text{-}Tb}, \alpha_{Th} \rightleftharpoons \alpha_{Tb}$ and $\beta_{Th\text{-}Ho} + \alpha_{Th} \rightleftharpoons \alpha_{Ho}$ at temperatures near 1320° and 1510°C. (auth)

10993 STUDIES OF HEAT-RESISTANCE OF BINARY NIOBIUM ALLOYS WITH TUNGSTEN, VANADIUM, AND TITANIUM. Vasil'eva, E. V.; Prokoshkin, D. A.; Popov, N. N.; Lazarev, E. M. Izv. Akad. Nauk SSSR, Metal., No. 6, 171-5(Nov.-Dec. 1967). (In Russian).

Heat-resistance characteristics of Nb with a diffusion migration of alloying elements and tests on the creep of binary niobium alloys with Ti, W, and V were studied at 1200 to 1900°C. (auth)

10994 LIMITED SOLUBILITY IN A LIQUID STATE IN THE BINARY SYSTEMS OF VANADIUM WITH COPPER, LANTHANUM, AND CERIUM. Efimov, Yu. V. Izv. Akad. Nauk SSSR, Metal., No. 6, 163-7(Nov.-Dec. 1967). (In Russian).

Studies were made of the limited solubility in liquid systems of vanadium with copper, lanthanum and cerium. Critical positions of the binary curves in the general areas of stratification were found and distribution of phase fields at temperatures exceeding monotectic temperatures of these systems was determined. (R.V.J.)

10995 HELIUM FIELD-ION MICROSCOPY OF HEXAGONAL CLOSE-PACKED METALS. Melmed, Allan J. (National Bureau

of Standards, Washington, D. C.). Surface Sci., 8: 191-205(July-Aug. 1967).

Among hexagonal close-packed (hcp) metals, only Re and Ru are capable of withstanding the rigors of field evaporation to produce the atomically smooth, geometrically regular surface needed for accurate analysis with the field-ion microscope. Some details of the field-ion microscopy of hcp metals are reported, along with the effects of field-evaporation conditions on the surface structure of Ru. A new tip-sharpening procedure was used for Ru, which is described in detail. Comparison of He field-ion micrographs of Ru and Re at 20 and 77°K disclosed significant differences. The Ru micrographs indicated differences in the edge structure of alternate successive layers, generally in accord with expectations from the 2h + 4k + 3l relation, whereas the Re micrographs did not show these differences. The effect of temperature and field strength on the structure developed by field-evaporation was analyzed, and the structures of the (100) or (10$\bar{1}$0) and (001) or (0001) plane regions are discussed in relation to their respective field-ion images. The atomic arrangement of curved hexagonal close-packed metal surfaces is more complex than curved surfaces of body-centered and face-centered cubic metals. (BBB)

10996 THE TERNARY SYSTEM, NIOBIUM–COBALT–SILICON. Skolozdra, R. V.; Kus'ma, Yu. B.; Gladyshevskii, E. I. Izv. Akad. Nauk SSR, Neorg. Mater., 3: 2016-20(Nov. 1967). (In Russian).

The ternary system Nb–Co–Si was investigated by x-ray methods and microstructural analysis. The isothermal profile at 800°C was constructed. The existence of the ternary compounds $\varphi(Nb_3CO_2Si_2)$, $\psi(Nb_{0.36}Co_{1.64})Si$, $T(Nb_6Co_{16}Si_7)$, λ_1 phases, and $\theta(Nb_4CoSi)$ were confirmed. The E phase has some increase of the Co concentration (its composition is $(Nb_{0.85}Co_{1.15})Si$). The solubility of Si in the μ phase of NbCo reaches approximately 12.5 at. % Si. The solubility of Nb and Co in binary silicides was insignificant. (tr-auth)

10997 PROBLEMS OF LOSS OF HARDNESS OF TUNGSTEN–NICKEL–IRON ALLOY IN HEATING. COMMUNICATION II. Frantsevich, I. N.; Teodorovich, O. K.; Bazhenova, L. G.; Minakova, R. V. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 84-91(Nov. 1967). (In Russian).

The results are presented of an investigation of loss of hardness of W–Ni–Fe alloy. By means of micro- and roentgenostructural analyses and by the methods of hardness and microhardness the structural changes are investigated in fusible phase—a bond in annealing after the preliminary cold strain. The temperatures of the beginning of recrystallization of the alloy fusible phase are determined and the diagram of this phase recrystallization is plotted. (auth)

10998 THE ORIGIN AND SIGNIFICANCE OF BANDING IN 18Ni(250) MARAGING STEEL. Cox, P. H. Salmon; Reisdorf, B. G.; Pellissier, G. E. (United States Steel Corp., Monroeville, Pa.). Trans. Met. Soc. AIME, 239: 1809-17(Nov. 1967).

Banding that occurred in plates rolled from the early production heats of 18Ni(250) maraging steel is described and related to the segregation of certain alloying elements (nickel, molybdenum, titanium), the extent of which was quantitatively evaluated by means of electron-microprobe analysis. The effect of banding on mechanical properties is discussed, with particular reference to observed directional differences in plane-strain fracture toughness of plates. It is shown that banding originates as interdendritic segregation during ingot solidification and persists in some degree through normal soaking and hot reduction to plate. The results of the study showed that heating sections of small laboratory-cast ingots at 2200°F for 4 hr was sufficient to markedly reduce microsegregation and to considerably improve mechanical properties. Hot rolling of 7-in.-thick ingot sections to ½-in.-thick plate effected a similar reduction of microsegregation, but resulted in even greater increases in ductility and toughness than that obtained by homogenization treatment alone. (auth)

10999 CO-EQUILIBRIUM PRESSURE OF TANTALUM–OXYGEN SOLID SOLUTIONS. Fromm, Eckehard; Heinkel, Otto (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 805-10(Nov. 1967). (In German).

CO-Equilibrium Pressure of Ta–O Solid Solutions. The dependence of the CO-equilibrium pressure over tantalum on temperature and on the content of dissolved oxygen and carbon has been determined at 1700 to 2000°C. The enthalpy of solution of carbon/monoxide in tantalum is –65 kcal/mol CO. The experimentally observed CO-equilibrium pressures follow the relation $p_{CO} \sim c_{CO}^{1.6}$ and don't prove exactly the Sieverts $\sqrt{p}$-law. In the temperature range of the experiments the terminal solubility of the Ta–C–O-solid solution with the C/O-ratio 1 lies between 0.2 and 0.6 mol-% CO. At temperatures above 2000°C the equilibrium is disturbed by the evaporation of volatile oxides. (auth)

11000 X-RAY-STUDIES ON COLD-WORKED HCP METALS AND ALLOYS. Krishnan, R. (Bhabha Atomic Research Centre, Bombay). Z. Metallk., 58: 811-13(Nov. 1967).

An x-ray study on cold-worked filings of hecp metals like zirconium, titanium, and hafnium and on hecp zeta phase alloys of silver-antimony and copper-germanium has been carried out. The fault probabilities have been evaluated from measurements of half-widths of the (101) and (102) reflections, using the (002) reflection as a standard for correcting the half widths for all effects other than that of stacking-faults. There is a definite growth fault probability in the pure metals studied here. For the hecp alloys, it is observed that the fault probability increases as the composition of the zeta phase alloy approaches the alpha phase boundary. (auth)

11001 THE QUASIBINARY SYSTEM UAl_2–NiAl. Petzow, G.; Exner, H. E.; Kiessler, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals, 14: 127-31 (1968). (In German).

Uranium–aluminium alloys with concentrations lying on the straight line between UAl_2 and NiAl, were examined by metallographic, x-ray and temperature-temperature difference measurements. These alloys exhibit a pseudo-binary behavior. A simple eutectic system was found, with a eutectic point at 27.0 ± 0.5 at. % Ni and 1150 ± 10°C. While homogeneous NiAl does not take up any uranium into solid solution, UAl_2 dissolves up to about 5.5 at. % Ni at the eutectic temperature, causing a concentration of the unit cell by about 0.3%. (auth)

11002 STUDY OF THE ISOTHERMAL SOFTENING PROCESSES OCCURRING IN UNDOPED TUNGSTEN WIRE (0.38 mm). Mima, Genjiro; Nakagiri, Akikazu. Nippon Kinzoku Gakkaishi, 30: 1042-7(1966).

The isothermal softening processes occurring in an undoped W wire (0.38 mm) which was prepared through the usual industrial production process has been studied mainly by tensile test and microscopic observations in the temperature range of 1100 to 1800°C. The tensile strength changes during isothermal annealing were compared with the microscopic structure changes and the results of x-ray measurements, and it is shown that they are in good agreement. It has been found that the softening takes place in several stages and that a large fraction of softening and a rapid decrease in elongation (nearly to zero) are observed in the final stage of softening. On the other hand, during the stage second to the last a marked increase in elongation takes place and no noticeable tensile strength change is observed. The activation energies for the last stage and the other stages of softening are found to be 66,000 cal/g-atom and 73,770 and 73,500 cal/g-atom. The characteristic microscopic structure corresponding to the last stage of softening is a coarse equiaxed grain structure, while the elongated grain structure is characteristic in the stage second to the last. The coarse equiaxed grain structure markedly differs from the ordinary recrystallization structure observed in the moderately or heavily cold drawn metals. It is considered that the coarse equiaxed grain structure corresponds to the microstructure which results from migration of small or medium angle boundaries rather than the so-called recrystallization structure (primary recrystallization structure). 10 ref. (Rev. Met. Lit.)

11003 FUNDAMENTALS OF GAS-SURFACE INTERACTIONS. Proceedings of the Symposium held on December 14–16, 1966 at San Diego, California. Saltsburg, Howard; Smith, Joe N. Jr.; Rogers, Milton (eds.). New York, Academic Press, 1967. 565p. (CONF-661209). DTIE.

Thirty papers and accompanying discussions are presented. The symposium was developed around three themes: the study of the surface itself (with or without adsorbed gases), the study of the gas phase interaction in which physical or chemical transformation of the gas resulted from the interaction, and the study of energy and momentum changes resulting from the gas-solid interactions. Extensive bibliographies are included. (P.G.C.)

Radiation Effects

Refer also to abstract 10447.

11004 (BNWL-CC-905) BURNUP DATA FROM HIGH EXPOSURE PLUTONIUM–ALUMINUM FUEL. Christensen, D. E.; Reppond, E. B.; Reardon, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1, 1966. Contract AT(45-1)-1830. 109p. Dep. CFSTI.

Burnup data obtained as the result of destructive analysis of irradiated high-exposure Pu–Al fuel are presented. Burnup

parameters in equation form and error propagation data are given in tables and figures. (M.C.G.)

11005 (BNWL-SA-1467) ULTRASONIC METHOD FOR NONDESTRUCTIVELY DETECTING RADIATION INDUCED EMBRITTLEMENT IN PRESSURE VESSEL STEELS. Hunter, David O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 16, 1967. Contract AT(45-1)-1830. 24p. (CONF-671011-3). Dep. CFSTI.

From Conference on Incipient Failure Diagnosis for Assuring Safety and Availability of Nuclear Power Plants, Gatlinburg, Tenn.

A preliminary report is presented on the use of the critical angle method of ultrasonic testing of radiation induced embrittlement of stainless steels used in reactor pressure vessels. At the present stage of the investigation it has not been determined if the method is capable of identifying the extent of damage simultaneously present such as neutron irradiation, fatigue, creep, and residual stresses. (P.G.C.)

11006 (ORNL-TM-2043) EFFECTS OF IRRADIATION ON THE MECHANICAL PROPERTIES OF TWO VACUUM-MELTED HEATS OF HASTELLOY N. McCoy, H. E. Jr. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 43p. Dep. CFSTI.

The mechanical behavior of two vacuum-melted heats of Hastelloy N was evaluated at 650 and 760°C. The material was subjected to several thermal-mechanical treatments and then irradiated at 650 and 760°C to a thermal dose of 2.3×10^{20} neutrons/cm^2. The results are compared with those for unirradiated specimens that were given a similar thermal treatment. The various thermal-mechanical treatments had some relatively small effects on the unirradiated tensile properties, but the creep properties were very similar. The primary effects of irradiation were reductions in the creep-rupture life and the rupture ductility in both creep and tensile tests. These observations are explained on the basis of helium production in the metal by the $^{10}B(n,\alpha)$ transmutation. (auth)

11007 (WCAP-3850-1) POST-IRRADIATION EXAMINATION OF CVTR FUEL ASSEMBLIES. Quarterly Progress Report for the Period Ending September 30, 1967. Balfour, M. G. (ed.) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1967. Contract AT(30-1)-3850. 36p. Dep. CFSTI.

Six CVTR fuel assemblies were received for post-irradiation examination. Special assembly G-2 (undefected) was examined by underwater periscope; the fuel rods were removed from special assembly G-1 and rod #24.732 (25.1 kW/ft. design) was observed to have broken into two sections approximately 13 inches from its lower end. It was examined thoroughly underwater. This and the remaining fuel rods from G-1 were transferred to the hot cells for further non-destructive examinations, including leak testing, profilometry, and stereomicroscopic examination. Rod removal from special assemblies G-3 and G-4 in the pool was unsuccessful, necessitating transfer and disassembly in the hot cells. Standard CVTR assemblies 502-1-18 and 502-2-31 were disassembled in the hot cells. Leak testing identified corner peripheral fuel rods #1475 and #1549, respectively, as the defected rods from these assemblies. Fuel rod #1475 was defected near the upper and plug weld, with an annular strip of cladding broken away at this point. Fuel rod #1549 contained two large (approximately 150 mils) holes in the cladding within the lower 10 inches of the rod. The defected rods and sister rods (i.e., those selected for destructive examination in addition to the defected rods) from the standard assemblies exhibited extremely heavy deposits of crud, locally exceeding 10 mils thickness. Crud mapping and sampling were included in the non-destructive examinations together with gamma scanning, profilometry, and stereomicroscopic examination. (auth)

11008 CONTRIBUTION TO THE STUDY OF THE HARDENING MECHANISMS BY GAS BUBBLES IN METALS. Levy, V.; Perraillon, B.; Adda, Y. Mem. Sci. Rev. Met., 64: 637-40 (July-Aug. 1967). (In French).

An electron microscope study on thin Al-Li alloy specimens containing He bubbles produced by neutron irradiation is reported. The presence of bubble induces hardening by a mechanism of the Orowan type. (tr-auth)

11009 STRESS-RUPTURE PROPERTIES OF IRRADIATED AND UNIRRADIATED HASTELLOY-TUBES. McCoy, H. E. Jr.; Wier, J. R. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 4: 96-104(Feb. 1968).

The stress-rupture properties of two heats of Hastelloy N tubing have been determined at 760°C in the irradiated and unirradiated conditions. Irradiation reduced the rupture life and the rupture strain but produced no detectable effects on the creep rate. The effects of irradiation are rationalized on the basis of the behavior of helium which is formed in the metal as a result of the $^{10}B(n,\alpha)^7Li$ with thermal neutrons. (auth)

11010 EFFECT OF DEOXIDATION PRACTICE ON THE SENSITIVITY OF STRUCTURAL STEEL TO IRRADIATION EMBRITTLEMENT. Powers, A. E. (General Electric Co., Schenectady, N. Y.). Contract W-31-109-eng-52. Nucl. Appl., 4: 105-8(Feb. 1968). (KAPL-P-3349).

Chemical determination of the distribution of nitrogen in low-alloy, pressure-vessel steels of known response to neutron irradiation indicates a relation between the amount of uncombined nitrogen and the degree of radiation sensitivity. The sensitive steels that were tested were of varying microstructure but were distinguished by having almost all of the nitrogen combined as aluminum nitride. Four out of five of the insensitive steels contained at least 38 ppM uncombined nitrogen. For unknown reasons, the fifth insensitive steel did not fit the pattern established by all the others. (auth)

11011 DESORPTION BY ELECTRON IMPACT: CARBON MONOXIDE, NITRIC OXIDE, AND OXYGEN ON TUNGSTEN. Yates, J. T. Jr.; Madey, T. E.; Payn, J. K. (National Bureau of Standards, Washington, D. C.). Nuovo Cim., Suppl. (1), 5: 558-81(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14-17, 1967. See CONF-670326.

The electronic desorption properties of three oxygen-bearing diatomic molecules chemisorbed on the same polycrystalline W ribbon were compared systematically. Experiments were performed to measure total ion current, ion energy distribution, and irreversibility of electron desorption. Results indicated that CO, NO, and O_2 adsorbed at ~300°K in a manner which produced a state of low ionic cross-section. States capable of producing high yields of ions on electron impact were observed to form only as coverage increased. It was found that on W, CO and NO are irreversibly affected by electron impact, whereas oxygen behaves in a reversible manner over many cycles of electron impact and readsorption. (J.G.B.)

11012 ELECTRON-IMPACT-CAUSED EFFECTS IN A NITROGEN AD-LAYER ON TUNGSTEN, INVESTIGATED BY MEANS OF A FEM. Ermrich, W. (Philips Zentrallaboratorium GmbH, Aachen). Nuovo Cim., Suppl. (1), 5: 582-5(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14-17, 1967. See CONF-670326.

Electron bombardment of γ-nitrogen was carried out at approximately 80°K. The change of the work function $\Delta\phi$ and of the virtual emitting area A, (A_0 = A after adsorption) was measured as a function of the number of electrons/cm^2 impinging upon the tungsten tip. The increase in ϕ and A was far above that measured for the clean surface. It was concluded that the cross section of the process varies with electron energy. Also, a noticeable structure of $\Delta\phi$ as a function of electron energy near threshold (~5 eV) was detected. After creation of the high work function layer, heating of the tip resulted in a decrease of the work function. (J.G.B.)

11013 ELECTRON-IMPACT DESORPTION OF CARBON MONOXIDE FROM TUNGSTEN. Redhead, P. A. (National Research Council, Ottawa). Nuovo Cim., Suppl. (1), 5: 586-97 (1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14-17, 1967. See CONF-670326.

Ion energy distribution measurements were used to estimate the relative populations in the adsorbed states. Separation of various adsorbed states (assumed to be virgin and α) was made on the basis of differing cross sections. Total desorption cross sections were considerably larger than ion desorption cross sections. The large ratio of neutrals to ions is discussed. The measurements on desorption cross sections were in reasonable agreement with previously reported results of field emission measurements. Experiments were also performed on threshold relationships and desorption of excited neutrals. (J.G.B.)

11014 INTERACTIONS BETWEEN LOW-ENERGY ELECTRONS AND ADSORBED CARBON MONOXIDE. Degras, D. A.; Lecante, J. (CEN, Saclay, France). Nuovo Cim., Suppl. (1), 5: 598-605(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14-17, 1967. See CONF-670326.

The interaction cross-sections of low-energy electrons and carbon monoxide adsorbed on molybdenum were studied. Previously reported results of the indirect analysis of the species

desorbed by electrons suggested that the physically adsorbed molecules were released as CO and CO^+, while the CO adsorbed in the highest level of the chemically adsorbed particles experienced a dissociative ionization which yields O^+ in the gas phase. These results were substantiated. Further work dealt with energy losses of the incident electrons in the adsorbed layer, and changes which occur in the surface potential of molybdenum at different temperatures and coverages. (J.G.B.)

11015 INTERACTIONS OF ELECTRONS WITH ADSORBED WATER. Klopfer, A. (Philips Zentral-Laboratorium GmbH, Aachen). Nuovo Cim., Suppl. (1), 5: 606-11(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

The effects of low-energy electron bombardment of polycrystalline nickel and tungsten ribbons during exposure to water were investigated. Results of mass spectrometric measurements indicated that water disappeared and molecular hydrogen and oxygen were desorbed. Measurements on tungsten led to the conclusion that in this case atomic oxygen was also evolved. (J.G.B.)

11016 THE STRENGTHENING MECHANISM IN NEUTRON IRRADIATED COPPER SINGLE CRYSTALS AFTER MILD ANNEALING. Koppenaal, T. J. Acta Met., 16: 89-95(Jan. 1968).

The thermally activated rate controlling mechanism for slip in neutron irradiated copper single crystals given post-irradiation annealing at 306°C has been investigated. Measurements are made of the temperature dependence of the flow stress at constant strain rate, and the strain rate dependence of the flow stress at constant temperature. The activation enthalpy for slip is determined as a function of effective stress, and the results indicate that H_0, the enthalpy at zero effective stress, is independent of the annealing at 306°C. The stress dependence of both the activation enthalpy and the activation volume in the post-irradiation annealed crystals is in agreement with Fleischer's theory for strengthening by tetragonal distortions. A low temperature athermal deformation process is observed in these crystals, and this observation helps to explain some of the previous conclusions regarding the deformation mechanism in post-irradiation annealed crystals. It is concluded that the post-irradiation annealing at 306°C does not change the thermally activated rate controlling slip mechanism. In addition, the effective obstacle size remains constant, independent of the annealing. (auth)

11017 ANNEALING SPECTRUM OF ELECTRON-IRRADIATED NIOBIUM AND TANTALUM. El-Salam, Ehab Mohamed Abd. Salt Lake City, Univ. of Utah, 1967. 98p.

Thesis.

An investigation of the annealing of defects in niobium and tantalum, induced by electron-irradiation using 1.95 MeV electron beam is described. The specimens were irradiated at 13.2°K and subsequently annealed at temperatures up to 301°K. Isothermal-isochronal annealing procedures were used. Tantalum specimens showed six main recovery peaks at temperatures 27.4, 34.2, 40.9, 85.8, 124.5, and 157.0°K with associated activation energies ranging from 0.069 to 0.483 eV and no observed recovery peaks from 157°K to 301°K. Niobium specimens showed seven recovery peaks at temperatures 14.9, 17.8, 24.0, 29.2, 85.8, 99.1, and 135.7°K with associated activation energies ranging from 0.043 to 0.393 eV and no observed recovery peaks from 135.7°K to 301°K. A brief sketch of the mathematical analysis for computation of these activation energies (in both liquid helium and liquid nitrogen temperature ranges) is given. Detailed comparisons are made between the damage production data, annealing spectrum for both metals and for those for noble metals. A comparison of the results with those obtained from neutron irradiation on niobium and tantalum is given. (Disser. Abstr.)

11018 EFFECTS OF THE SPACE ENVIRONMENT OF MATERIALS. Science of Advanced Materials and Process Engineering Proceedings. Volume 11. 11th National Symposium and Exhibit, St. Louis, April 19–21, 1967. North Hollywood, Calif., Western Periodicals Co., 1967. 320p. (CONF-670435). DTIE.

The second volume of The Effects of Space Environment on Materials contains twenty-nine papers. The definition and simulation of the space environment are covered as well as the effects of space environment on various materials. A separate abstract was prepared for each of nine papers. (D.H.M.)

For abstracts of individual papers see: 10673, 10919, 10961, 10962, 11093, 11094, 11104, 11105, and 11331.

11019 EFFECT OF NUCLEAR RADIATION ON OXIDIZED SILICON SURFACES. Hood, Jerry Aundos. Albuquerque, N. Mex., Univ. of New Mexico, 1967. 127p.

Thesis.

A model of semiconductor surfaces is presented which takes into account the radiation damage and may be used to predict the resulting change in electrical characteristics. The surface controlled devices studied were the metal-oxide-silicon capacitor and the insulated gate field effect transistor. For both devices, the surface is a thin metal film deposited on an oxidized silicon crystal. Both devices operate by inducing a particular charge distribution at the silicon surface with a bias voltage between the metal film and the silicon crystal. It is this voltage-charge relation which changes with irradiation. With the use of silicon alloy diodes, the radiation-induced defects in the silicon crystal are shown to have negligible effect on the surface controlled devices, at radiation levels where a significant change in characteristics is observed. The radiation damage of interest is, therefore, in the oxide and/or the oxide-silicon interface. The oxide is modeled using energy band characteristics. The total energy deposited in the oxide due to the radiation flux is converted to free-electron and trapped-hole pairs. The transport and recombination of the electrons result in a positive charge in the oxide. The distribution of these positive charges depends on properties of the oxide, the energy absorbed from the radiation, and the bias voltage across the oxide at the time of irradiation. This distribution of positive charge is used to calculate the change in the relation between the bias voltage across the oxide and the charge induced in the silicon surface. The positive charges in the oxide are stable for many months and temperatures in excess of 200°C are required for annealing in any reasonable time. By applying the model, device types and design changes can be compared for radiation tolerance. (Disser. Abstr.)

11020 DEISTVIE IONIZIRUYUSHCHIKH IZLUCHENII NA METALLY I SPLAVY. (Ionizing Radiation Effects on Metals and Alloys). Konobeevskii, S. T. (ed.). Moscow, Atomizdat, 1967. 116p.

Effects of electron and γ radiation on metals and their crystal structure are discussed. A brief review is given of the physical properties, electric conductivity, Young's modulus, mechanical characteristics, magnetic and coercive forces of metals and alloys treated by ionizing radiation. The influence of ionizing radiation on the diffusion and ordering processes in metals and alloys is also discussed. (177 references) (R.V.J.)

Ceramics and Cermets

Refer also to abstracts 10911 and 10913.

11021 (GA-7390) ADVANCED GRAPHITE FUEL SYSTEMS. Quarterly Progress Report for the Period Ending August 14, 1966. Bokros, J. C.; Engle, G. B.; Price, R. J.; White, J. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 9, 1966. Contract AT(04-3)-167. 39p. Dep. CFSTI.

Progress on research to determine the properties and structure of various types of carbon and graphite used in high-temperature advanced reactors is reported. Measurements of changes in linear dimensions, density, apparent crystallite height (L_c), and layer spacing of fast-neutron irradiated pyrolytic carbon were made. At 560°C the carbons became denser during irradiation, with densification rate following first-order kinetics. Above 1100°C carbons with initial densities less than 2.06 g/cm^3 densified but those with higher densities became less dense. Dimensional changes were primarily dependent on preferred orientation. Isochronal annealing of irradiated pyrolytic carbon produced resistivity changes of ~7% in those specimens irradiated at 540, 620, and 890°C. Measurements of lattice parameters of pyrolytic carbon and crystalline graphite as a function of temperature up to 1400°C showed identical c-axis expansion rates, indicating that intercrystalline elastic reactions are not large in pyrolytic carbon. (P.G.C.)

11022 (NYO-1710-71) RESEARCH ON GRAPHITE. Summary of Work Completed for the Period, April 1, 1967–March 31, 1968. Walker, P. L. Jr.; Palmer, H. B.; Diethorn, W. S.; Kline, D. E. (Pennsylvania State Univ., University Park). Dec. 20, 1967. Contract AT(30-1)-1710. 83p. Dep. CFSTI.

The results of graphite research are summarized. The four main subjects investigated were carbon formation and graphitization, gas-graphite interaction and solid state studies, the mechanism of fission gas diffusion in graphite, and the dynamic mechanical properties of carbon and graphite. (L.C.L.)

11023 HYDROGEN ABSORPTION AND ITS DISTRIBUTION IN ZIRCONIUM ALLOYS FOR CLADDING MATERIAL OF LIGHT WATER POWER REACTOR. Mishima, Yoshitsugu; Takahashi, Naoaki (Tokyo Univ.). Sogo Shikensho Nempo, 25: 143-8(Dec. 1966). (In Japanese).

Methods to add intended amount of hydrogen into zirconium are reported. Distribution of hydrogen in several binary zirconium alloys when heated for 20 days under temperature gradient as en-

countered under reactor conditions is studied by analyzing hydrogen content using a vacuum fusion method. Effect of the respective alloying elements is clearly recognized. Hydrogen absorption by Zircaloy and its fundamental binary and ternary alloys with 800 to 2,500 ppM of oxygen was studied by optical microscope. (NSA of Japan)

11024 METHOD OF PREPARING A FUEL ELEMENT OF FISSIONABLE OXIDE AND BURNABLE POISON. Rose, Richard G. (to Westinghouse Electric Corp.). U. S. Patent 3,361,857. Dec. 3, 1965.

The design of a fuel element of precise dimension embodying a predetermined proportion of a burnable poison for use in a nuclear reactor is given. Fissionable oxide material, a burnable poison comprising an inorganic compound, and an organic binder are mixed into a homogeneous blend. The mixture is compressed and heated in a vacuum for 1½ to 3 hr at 250 to 350°C, heated in a hydrogen atmosphere for 1 to 3 hr at 600 to 700°C, and sintered in a hydrogen atmosphere for 1 to 6 hr at 1500 to 1800°C. (J.C.W.)

Corrosion and Erosion

Refer also to abstracts 10938 and 12006.

11025 (EUR-2762) THE INFLUENCE OF MASS TRANSFER ON THE KINETIC OF GRAPHITE OXIDATION BY LOW CONCENTRATION OF OXIDISING IMPURITIES IN AN INERT CARRIER GAS. Valette, L. J. (Atomic Energy Establishment, Winfrith (England)). 1967. 199p. Dep.

Thesis. Submitted to Univ. of Brussels, Belgium.

Investigations have been carried out in the research and development program of DRAGON to find the reaction rates of chemical impurities present in helium with graphite at high temperature. In the temperature range to be expected in a HTGCR the reaction rates can be mass transfer controlled. A pressurized loop has been built to investigate the mass transfer controlled reactions. The experimental investigations are correlated with theoretical predictions based on the boundary layer concept. In most cases a good prediction of the rates can be achieved by these theories and in the remaining cases a good insight in the mechanism of the mass transfer could be obtained by the analysis of the boundary layers surrounding the reacting body. (auth)

11026 THE MEASUREMENT OF IONIC MOBILITIES IN THE ANODIC OXIDES OF TANTALUM AND ZIRCONIUM BY A PRECISION SECTIONING TECHNIQUE. Whitton, J. L. (Chalk River Nuclear Labs., Ont.). J. Electrochem. Soc., 115: 58-61 (Jan. 1968).

The technique of removing thin sections of anodic oxides by vibratory polishing was used in conjunction with implantation of anion, cation, and inert gas radiotracers to measure the mode of anodic oxide formation on Zr and Ta. The measured transport number for metal during the growth of Ta_2O_5 (0.28) is in good agreement with previous work. ZrO_2 is shown to grow by oxygen migration and preliminary experiments suggest that the process occurs by rapid movement of the oxygen along defects. Comparison of the movement of anion and cation radiotracers with that of an inert gas provides additional evidence that xenon and krypton may be regarded as immobile markers for use in oxidation studies. (auth)

11027 UNUSUAL LOW TEMPERATURE OXIDATION BEHAVIOUR OF US AND US–ZrS SOLID SOLUTIONS. Ban, Z.; Despotovic, Z.; Tudja, M. (Univ. of Zagreb). J. Nucl. Mater., 25: 114-18(1968).

US and US–ZrS solid solutions were prepared and weight gains in an oxygen atmosphere studied. The weight gain in the temperature range between room temperature and 200°C corresponded to the incorporation of oxygen into the solid solution. Above 300°C a relatively steep increase in weight began, suggesting further incorporation of oxygen into the US or $(U_1Zr)S$ lattice. The possibility is suggested that the whole oxidation process proceeds by the incorporation of oxygen on 4 octahedral and 8 tetrahedral sites vacant in the lattice so that the ideal composition of the filled-up cell should be US_2. Results indicate that at 360°C a stable structure is obtained in which all the tetrahedral sites are occupied by oxygen and 0.36 of the remaining octahedral sites are filled in a random fashion by sulfur and oxygen atoms. (M.C.G.)

Preparation and Fabrication

11028 (UCRL-Trans-10144) EXAMINATION OF ROLLED ALPAX/Al–Al_2O_3 SINTERED MATERIALS. APPLICATION OF BRAZING TO COMPONENTS OF SINTERED Al–Al_2O_3 MATERIALS. Herenguel, J.; Leymonie, Cl. Translated by B. Haro for Univ. of California, Lawrence Radiation Lab., Livermore, from Mem. Sci. Rev. Met., 61: 43-54(1964). 36p. (CONF-167-6). Dep. CFSTI. JCL $3.60 fs, $1.28 mf.

From Journees Metallurgiques d'Automne, Paris, Oct. 1962.

The construction of complex assemblies (reactor cladding, for instance) with the aid of Al–Al_2O_3 sintered materials poses the problem of the bonding of the components. Despite the improvements brought about in products by reducing the residual gas content, the welding of Al–Al_2O_3 sintered elements is a delicate operation. Brazing seems to offer worthwhile possibilities. Alpax was chosen as the brazing agent. Co-rolling was used to carry out studies on alpax-sintered Al–Al_2O_3 joints. Acceptable bonds were obtained as a result of co-rolling at 350 and 450°C. However, after annealing at 450, 500 and 560°C to simulate the temperature conditions to which the cladding is likely to be subjected in practice, a noticeable stripping of the Si particles in the alpax was observed in the diffusion zone, probably due to a pronounced Kirkendall effect. The same experiments were carried out again, the normal alpax being replaced by a grade to which 0.02% sodium has been added. Under these conditions the diffusion was no longer disturbed by the presence of coarse particles of Si and the diffusion zone is free of incipient internal fractures. Brazing pieces of sintered Al–Al_2O_3 seems feasible. Tests have been carried out on sheets of sintered Al–Al_2O_3 and on units consisting of a bar and a tube. The bond obtained is in all cases of good quality, unimpaired by diffusion. The brazings obtained have a high mechanical resistance, which under certain conditions is superior to that of the sintered materials themselves. Furthermore, they are entirely unaffected by helium. Brazing Al–Al_2O_3 by refined alpax is feasible and a fairly easy means of assembling complex units. (auth)

11029 (UCRL-Trans-10193) PRODUCTION OF SHAPED ARTICLES FROM SINTERED HIGH-PURITY CALCIUM FLUORIDE OF NATURAL AND SYNTHETIC ORIGIN. Wlodarski, R. Translated by A. M. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from Nukleonika, 9: 493-6(1964). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The experiments indicate that natural calcium fluoride is the best raw material for the production of sintered shapes. It has a high bulk density (1.7 g/cm³) and a shrinkage of not more than 3 to 4%. Preliminary firing at 800°C is necessary to avoid spalling of the resulting articles. Synthetic calcium fluoride has a low bulk density (1.01 g/cm³) and very high shrinkage (up to 40% on sintering at 1100°C), and requires a different method if it is to be made into shaped articles. Hence each material requires a specific procedure. It may be concluded that shaped products of various form and size can be made from sintered calcium fluoride if the described conditions are maintained. (auth)

11030 BEHAVIOR OF ZIRCONIUM UNDER CARBON MONOXIDE. Guerlet, J.-P.; Lehr, P. (CNRS, Vitry-sur-Seine, France). Mem. Sci. Rev. Met., 64: 745-56(Sept. 1967). (In French).

Below 850°C only the ZrO_2 oxide is formed. At higher temperatures the CO reduction corresponds to a surface carburizing reaction of the metal. At the highest temperatures used (1100°C), zirconia is no longer formed and the ZrC carbide is obtained. (tr-auth)

11031 APPLICATION OF SOL–GEL PROCESSES TO INDUSTRIAL OXIDES. Fletcher, J. M.; Hardy, C. J. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Ind. (London), No. 2, 48-51(Jan. 13, 1968).

Discussion is presented on the preparation of sols, formation of gels from sols and calcination to oxides, and possible forms of sols and gels and their applications. A typical laboratory study of a sol-gel process is presented. The sols discussed are in the concentration ranges 0.5 to 6 M metal or 100 to 1000 g/l oxide) and of density 1.3 to 1.8 g/ml. They are stable and usually of low viscosity, due to a small concentration of a stabilizing anion. In the nuclear fuel field application of the process affords processing advantages, and gives products of controlled composition, shape, and size. The process can also be usefully applied in some non-nuclear fields. The property of forming concentrated sols has been demonstrated mainly for elements in the +3 and +4 oxidation states. Formation of gel from sol is a key stage in control of the shape and size of the final oxide product. The merits of a sol-gel route may lie in making either an existing product by less costly stages, or by avoiding inefficient and unattractive stages; or in making new products, such as oxides readily dispersible in water; or by making products with improved properties, such as cermets. Materials studied include ThO_2, ZrO_2, UO_2, rare earths, and Al_2O_3. (UK)

11032 CERMET MATERIALS IN NUCLEAR TECHNOLOGY. Meerson, G. A. Porosh. Met., Akad. Nauk Ukr. SSR, No. 11, 50-64(Nov. 1967). (In Russian).

Soviet works on powder metallurgy methods used to produce materials for nuclear reactors are reviewed. Reduction of UO_2

with calcium has been investigated. Thermochemical studies showed that the heat of reaction $UO_2 + 2Ca = U + 2CaO + 4565$ cal heats up the material to 1300°C. When the temperature is raised above the melting point of uranium, the metal particles take the shape of smooth spheres which can be enlarged by adding $CaCl_2$. The obtained uranium powder can be compacted by hot pressing at 500°C under a pressure of 5 tons/cm². Almost pore-free uranium ingots or articles, containing 0.04% carbon and 0.2–0.3% oxygen, were obtained by this method. A method of dispersion strengthening uranium by the introduction of refractory compounds such as UO_2, UC, or UBe_{13} has been investigated. A method of manufacturing thorium articles from electrolytic and calciothermic powders was developed. Articles made of the powders by pressing under 10–12 tons/cm² had a relative density of 95 to 97%. Uranium carbide can be pressed into high-density articles. A density of 90% was reached by cold pressing and sintering in vacuum at 2100°C for 2 hr. By hot pressing in vacuum at 1800 to 1850°C under a pressure of 300 kg/cm², uranium-carbide articles with 95% density were obtained. A solid solution of UC–ZrC in powder form was obtained by reduction of $UO_2 + ZrO_2$ mixture with carbon black in vacuum at 2000°C. The possibility of obtaining ZrC sheets (1 mm thick) without hot pressing was investigated. Sheets with a density of 5.7 g/cm³ were obtained by sintering ZrC and 12 to 15% Zr pressed powders at 2200°C. Pure beryllium can be obtained by electrolysis or distillation. The powder is cold pressed into brickets which are sintered at 1180 to 1200°C and cold or hot pressed again, resulting in beryllium with 1.75 to 1.82 g/cm³ density. Sintered magnesium or magnesium alloys can be strengthened by dispersion inclusions of MgO. Tests of dispersion strengthened Mg + MgO showed that it preserves its strength after being heated to high temperatures and that it has low creep rate. Alloying with beryllium increases the alloy's high-temperature oxidation resistance. (ATD)

11033 REDUCTION OF MOLYBDENUM TRIOXIDE BY ALUMINIUM. Gupta, C. K.; Jena, P. K. (Bhabha Atomic Research Center, Bombay). J. Less-Common Metals, 14: 148-50 (1968).

A method is described for producing massive molybdenum metal by aluminothermal reduction of molybdenum trioxide. As-reduced metal samples are consolidated and refined by non-consumable arc and electron-beam melting. (F.S.)

11034 METHOD OF PRODUCING A SINTERED URANIUM DIOXIDE NUCLEAR FUEL ELEMENT CONTAINING A BORIDE. Watanabe, Takaaki; Ogura, Tadashi; Kondo, Yoshiaki; Nagasawa, Masaji (to Mitsubishi Atomic Power Industries, Inc.). U. S. Patent 3,349,152. Mar. 6, 1965. Priority date Mar. 19, 1964, Japan.

A method of producing sintered composite nuclear fuel elements comprises forming a mixture of uranium dioxide and a boride selected from the group consisting of zirconium boride, titanium boride and molybdenum boride and an organic forming agent selected from the group consisting of paraffin, polybutene, and polyisobutylene and a hydrocarbon solvent for forming agent, into a member, maintaining the member in an atmosphere of hydrogen at a temperature of about the boiling point of the forming agent for more than 10 hours to remove the forming agent and to preliminarily sinter the member, exposing the preliminarily sintered member to a vacuum having an absolute pressure no greater than 10^{-4} mm Hg without exposing the preliminarily sintered member to air heating the preliminarily sintered member in vacuum to a temperature above 1300°C, and maintaining the member at that temperature for a time sufficient to complete the sintering. (auth)

11035 SMALL SPHERICAL NUCLEAR FUEL PARTICLES AND PROCESSES OF MAKING SAME. Swanson, Roger E. (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,355,393. Sept. 14, 1965.

A method is described for producing small spherical particles about 10 to 500 μ in diameter adapted to heating to produce a preform useful for making spherical particles having a diameter of about the same order of magnitude as the original particles and containing from about 1 to 65 wt % of an additive substance of the group consisting of carbon and refractory metallic oxides homogeneously dispersed in finely divided form. When the additive is carbon, the amount of additive is from about 1 to about 15 wt %. (TSS)

11036 NUCLEAR REACTOR FUEL. Robertson, John Archibald Law (to Atomic Energy of Canada Ltd.). U. S. Patent 3,354,044. Dec. 17, 1964. Priority date Oct. 10, 1962, Canada.

The fuel for an element comprises initially a shaped ceramic mass of a hyperstoichiometric dioxide of a metal selected from the group consisting of U, Pu, Th, and mixtures thereof, and a deoxygenating getter metal selected from the group consisting of Th, U, Pu, Ta, Mo, W, and mixtures thereof. The shaped hyperstoichiometric dioxide mass and getter metal is heat treated at a temperature of above about 1500°C under at least substantially oxygen-free deoxygenating conditions, until at least part of the dioxide mass becomes hypostoichiometric with the oxygen to metal ratio of the dioxide mass being reduced to below 2.0 but above 1.90. (TSS)

11037 URANIUM CARBIDE–PLUTONIUM PHOSPHIDE AS A REACTOR FUEL. Kruger, Owen L.; Moser, John B.; Thompson, James W.; Mailhiot Robert E. (to United States Atomic Energy Commission). U. S. Patent 3,362,914. Jan. 9, 1968.

A fast breeder nuclear reactor fuel consisting of a uranium carbide and plutonium phosphide mixture is described. (AEC)

11038 PYROLYTIC GRAPHITE AND NUCLEAR FUEL PARTICLES COATED THEREWITH. Bokros, Jack C.; Schwartz, A. S. (to United States Atomic Energy Commission). U. S. Patent 3,361,638. Jan 2, 1968.

The design of nuclear fuel particles with cores of fissile or fertile material surrounded by fission-product retentive layers of pyrolytic graphite having three-dimensional crystalline structure and layer plane spacings of from 3.35 to about 3.37 Å is presented. An additional layer of spongy pyrolytic carbon may be disposed immediately adjacent the fuel core. (AEC)

11039 CERAMIC COMPOUND ON THE BASIS OF BeO AND La_2O_3 FOR CRUCIBLES IN WHICH FISSILE METALS AND ALLOYS ARE FUSED AND PROCESS FOR THE PREPARATION THEREOF. Auriol, Alain; Lanaspeze, Pierre; Wurm, Joseph-Gerard (to European Atomic Energy Community). British Patent 1,096,588. Dec. 29, 1967. Priority date Mar. 24, 1964, Belgium.

A method is described for producing crucibles capable of resisting nuclear fissile materials, especially U, in fusion. The crucibles are formed of, or have a lining formed of, La_2BeO_4 formed from the oxides BeO and La_2O_3. A mixture of the oxides BeO and La_2O_3 are prepared in finely divided form with the oxides present in equimolecular proportions with or without a minor excess of either of the oxides. The mixture is treated with a plasticizer or binding agent, and the mixture is compressed into crucible form without thermal pretreatment. The chemical reaction and calcination are carried out simultaneously by heating for several hours at 1200 to 1300°C. (B.L.M.)

11040 IMPROVEMENTS IN OR RELATING TO FUEL BEARING COMPONENTS FOR NUCLEAR REACTORS. Redding, Geoffrey Brian (to United Kingdom Atomic Energy Authority). British Patent 1,099,367. Jan 17, 1968. Filed Nov. 11, 1963.

A method is described for making refractory fuel-bearing components having annular regions of different compositions for use in high temperature gas-cooled reactors. The ceramic fuels are built up from particles having one or more coatings of fission product-retaining materials such as pyrolytic carbon or silicon carbide. The fuel-bearing components may be cylindrical or tubular in shape. Either graphite or graphite-silicon carbide tubes contain a region in which a mixture of coated particles of nuclear fuel, powdered carbon, and a polymerizable binder are consolidated in the die simultaneously by heating the mixture to polymerize the binder. (F.S.)

Properties Evaluations

Refer also to abstracts 10434 and 10481.

11041 (EUR-3655) ELASTIC NEUTRON DIFFRACTION ANALYSIS OF A POWDER SAMPLE OF UC. Bonomo, M.; Colella, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Sept. 5, 1967. 10p. Dep.

The neutron diffraction pattern of a powder of uranium monocarbide has been obtained by means of a triple axis spectrometer in conventional and elastic diffraction at room temperature. The atomic mean square displacements are different in the two cases. It is concluded that an appreciable inelastic contribution is present in the case of conventional diffraction. (auth)

11042 (EURAEC-1933) A STUDY ON THE RELEASE OF FISSION GASES FROM UO_2 SAMPLES IRRADIATED TO VARIOUS DOSES. Quarterly Report No. 7, April–June 1967. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Sept. 1967. Contract 043-65-TEEI(RD). 11p. (EUR-3757). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Ten diffusion experiments were performed at 1400°C on pellets, fused grains, fused powders, and hot-pressed powders irradiated to various doses. (M.C.G.)

11043 (GA-7075) UNIFYING COATING PARAMETER. Bokros, J. C.; Schwartz, A. S. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 4, 1966. Contract AT(04-3)-167. 7p. Dep. CFSTI.

In a previous study of the relationship between the deposition conditions and the structure of carbons deposited in fluidized beds (Beatty, et al., Nuclear Applications, 1,560(1965)), several coating variables were combined into a single unifying parameter in order to simplify the presentation of the data. It is shown that the unifying parameter selected may not uniquely determine the structure of the carbon deposited but may obscure the relations that exist between the deposition conditions and the structure of the carbon deposited. (M.C.G.)

11044 (GEAP-5358) THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 1. Aitken, E. A. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Nov. 1967. Contract AT(04-3)-189. 9p. Dep. CFSTI.

The thermodynamic behavior of PuO_2-UO_2 solid solutions is described. The initial effort is a melting point study of nonstoichiometric compositions. Capsules containing sintered pellets of PuO_{2-x}, where $0 < x < 0.40$, were assembled for measurement of their melting behavior by the thermal arrest method. A conceptual model of the liquid-solid phase diagram of the urania-plutonia system was developed by using existing data and regular solution theory to account for melting point maximum at $U_{0.8}Pu_{0.2}O_{1.97}$. Preliminary analysis of the model indicates that a single interaction constant, characteristic of regular solutions, does not adequately fit the limited available data. (auth)

11045 (LA-3758) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 2. Summary of Progress, May 1-July 1, 1967. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 20p. Dep. CFSTI.

Research and development on carbons and graphites was undertaken to increase the understanding of their properties and behavior as engineering materials. The microstructures of natural, commercial, and experimental carbons and graphites were examined. The physical and mechanical properties of the materials were measured as functions of formulation, treatment, and environmental variables. Raw materials and manufacturing techniques were investigated, improved, and varied systematically to try to create specific internal structures believed to be responsible for desirable combinations of properties. (L.C.L.)

11046 (ORNL-TM-2061) COATED PARTICLE FUELS DEVELOPMENT AT OAK RIDGE NATIONAL LABORATORY FOR PERIOD JANUARY 15, 1967 TO OCTOBER 15, 1967. Coobs, J. H.; Sisman, O. (comps.) (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 102p. (CONF-671207-1). Dep. CFSTI.

From 13th AEC Coated-Particle Fuels Working Group Meeting, San Diego, Calif.

Work is reported on optimizing fuel element design and developing fabrication methods amenable to an economical fuel cycle. Research results indicate that either carbide or oxide kernels can be used effectively in coated particles. Oxide fuel particles are produced by the sol-gel process. Testing and evaluation of coated oxides continues. A comparison of solid fission product release from coated oxide and carbide particles during irradiation and postirradiation heating continues. Various coatings were studied. (F.S.)

11047 (JPRS-42628) PROPERTIES OF SOME CERAMIC AND INSULATING MATERIALS. Translation of Several Articles from Various Russian-Language Sources. 42p. (TT-67-33256). CFSTI.

Four articles are included. A separate abstract was prepared for one of them. Articles not abstracted are on: physical properties of aluminum, electric conductivity and dielectric losses in polyvinyl chloride plasticized resin, and dielectric permeability and dielectric losses in some ceramic materials in strong high-frequency electric fields at high temperatures. (M.H.R.)

For an abstract of the individual section see: 11493.

11048 THE SYSTEM $NbCl_5$-Nb_2O_5. PART V. THE P-T-x SPACE MODEL AND THE THERMODYNAMIC PROPERTIES OF $NbOCl_3$. Hart, W. 'T. Meyer, G. (Laboratorium voor Algemene en Anorganische Chemie, Delft, Netherlands). Rec. Trav. Chim., 86: 1191-8(Nov. 1967).

Results of the vapor pressure measurements and analyses of the phases occurring in the different equilibria are used to derive the P-T-x space model for the binary system. The P-T and T-x projections and the most important P-x and T-x sections are given. The thermodynamic constants of $NbOCl_3$ are given. (auth)

11049 THEORETICAL CONSIDERATIONS ABOUT THE CRACKING OF COATED PARTICLES. Drittler, K. Atomkernenergie, 13: 13-18(1968).

Using the formulas of Prados and Scott for outer elastic coatings, a system of crack configurations for coated particles was deduced. Since, this classification is complete in a certain way, and many micrographs of coated particles show these crack configurations, it should be an assistance in improving coated particles for given operation conditions. (auth)

11050 DIFFUSION OF ^{239}Pu AND ^{241}Am IN α-ALUMINA. Fiedler, W.; Bobleter, O. Atomkernenergie, 13: 57-9(1968). (In German).

In connection with the application possibilities of alumina in nuclear technology, the diffusion of ^{239}Pu(IV) and ^{241}Am(III) in highly sintered, pure α-alumina was examined in the temperature region from 1200 to 1450°C. Thin layers of the active substance were evaporated in high vacuum, and diffusion determined by the alpha-absorption method. The diffusion equations were calculated from the diffusion coefficients at different temperatures: for ^{239}Pu, $D = 1.54 \times 10^8 \cdot \exp[-(142{,}200 \pm 6{,}000/RT]$ cm^2sec^{-1} and for ^{241}Am, $D = 4.94 \times 10^8 \cdot \exp[-(135{,}000 \pm 7{,}000)/RT]$ cm^2sec^{-1}. (auth)

11051 THERMAL CONDUCTIVITY OF PuO_2 AS DETERMINED FROM THERMAL DIFFUSIVITY MEASUREMENTS. Lagedrost, J. F.; Askey, D. F.; Storhok, V. W.; Gates, J. E. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl., 4: 54-61(Jan. 1968).

The thermal conductivity of PuO_2 as determined by thermal diffusivity measurements at 250 to ~1200°C is presented. Specimens of PuO_2 with confirmed stoichiometry were fabricated by hot isostatic pressing of powder to densities of 96.5 and 81.9% (theoretical). The thermal diffusivity of four specimens, two of each density, was measured by the heat pulse technique using a laser as the heat source. The data indicated that the thermal conductivity of PuO_2 is lower than that of UO_2, and decreases with increasing temperature at 250 to 1000°C in an approximate 1/T relation. Values range from 0.06 W/cm°C at 300°C to 0.025 W/cm°C at 1200°C. An apparent reduction of the PuO_2 was observed at temperatures above 1200°C. (auth)

11052 HERTZIAN STRESS CRACKS IN BERYLLIA AND GLASS. Turner, D. N.; Smith, P. D.; Rotsey, W. B. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). J. Amer. Ceram. Soc., 50: 594-8(Nov. 21, 1967).

The effect of Hertzian stresses resulting from loads acting at the points of contact of beryllia spheres was determined. As-drawn glass and glass ground with various grades of silicon carbide were indented with beryllia spheres, 1 in. in dia. Also, pairs of these beryllia spheres were pressed together. Circular cracks due to Hertzian stresses were produced; an optical technique was developed for detecting them in a beryllia surface. The outer crack radius was proportional to the cube root of the maximum applied load. Average values obtained for the respective inner crack radii were used to determine average values of the minimum load to fracture these materials. The average minimum load to fracture of 1-in.-dia beryllia spheres in air at room temperature under dynamic loading was 235 lb. The crack radius in glass and beryllia was about 20% greater than the radius of the contact surface. This was not significantly affected (in glass) by flaw density. It is considered that the Hertz analysis does not give the correct location and value of the maximum tensile stress when finite displacements of material occur. (auth)

11053 EQUILIBRIUM OXYGEN PRESSURES OVER SOLID SOLUTIONS OF URANIA-YTTRIA AND URANIA-LANTHANA AT 1100^0 TO 1400^0C. Hagemark, K.; Broli, M. (Technical Univ. of Norway, Trondheim). J. Amer. Ceram. Soc., 50: 563-7(Nov. 21, 1967).

Using a thermobalance, the oxygen content of urania containing small amounts of yttria or lanthana was determined as a function of the oxygen partial pressure at 1100 to 1400°C. Values for the partial free enthalpy, the partial enthalpy, and partial entropy of oxygen were calculated. Equilibrium oxygen pressures over the solid solutions (U, Y, or La)O_{2+x} were higher than for pure UO_{2+x}. Both the partial enthalpy and partial entropy of oxygen decreased with the addition of yttrium and lanthanum, the change being larger in the latter case. The effects observed experimentally are discussed on the basis of differences in charge and size of the foreign cation relative to the uranium ion. (auth)

11054 CREEP AND CREEP FRACTURE OF A Ni-20Cr-$2ThO_2$ ALLOY. Wilcox, B. A.; Clauer, A. H.; McCain, W. S. (Battelle Memorial Inst., Columbus, Ohio). Trans. Met. Soc. AIME, 239: 1791-5(Nov. 1967).

The creep and creep-fracture behavior of a Ni-20Cr-$2ThO_2$

alloy has been studied at 816 to 1038°C and stress range 4000 to 19,000 psi. Specimens having their axes either parallel or transverse to the final sheet-rolling direction were tested in air, and the apparent activation energy for creep was found to be 92 kcal per mole, regardless of specimen orientation. The stress dependence of the steady-state creep rate, ϵ_s, was satisfied by $\epsilon_s \propto \sigma^n$, where n depended on orientation; n = 9.7 for material transverse to the rolling direction and n = 24.3 for material parallel to the rolling direction. In the latter case, the relation $\epsilon_s \propto e^{B\sigma}$ with $B = 1.7 \times 10^{-3}$ psi^{-1}, was also valid. The rupture strength of material parallel to the rolling direction was ~1.5 times greater than the transverse rupture strength. Several tests in vacuum revealed that here the creep rate was higher and rupture life lower than for comparable tests in air. (auth)

11055 SOLID-SOLUBILITY RELATIONSHIPS AND ATOMIC SIZE IN NaCl-TYPE URANIUM COMPOUNDS. Baskin, Y. (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 239: 1708-12(Nov. 1967).

Solid-solubility relationships in the pseudobinary systems UAs–UP, UAs–US, UAs–UC, and UAs–UN were investigated. The first two systems exhibit complete mutual solubility, whereas the component compounds in the other two systems are immiscible. These data together with solid-solubility data for six additional pseudobinary systems, were analyzed for compliance with the Hume-Rothery rules for metallic systems. The relative size difference of the component nonmetal atoms was found to be the dominant factor determining the extent of solid solubility between the NaCl-type uranium compounds. The anionic and covalent radii of the nonmetal atoms appear to be inadequate for these systems, but computed radii based on rare earth compounds yield consistent results for the uranium compounds. (auth)

11056 THERMAL PROPERTIES OF TANTALUM MONOCARBIDE AND TUNGSTEN MONOCARBIDE. Chang, Y. A. (Aerojet-General Corp., Sacramento, Calif.). Trans. Met. Soc. AIME, 239: 1685-91(Nov. 1967).

Heat content values of tantalum monocarbide and tungsten monocarbide have been determined at 325 to 985°K by means of a drop-type diphenyl ether calorimeter. Based on the values obtained and those available in the literature, best values of C_p, $H_T - H_{st}$, $S_T - S_{st}$, and $(G_T - H_{st})/T$ were selected and computed from 298.15°K to temperatures close to their respective melting points. At temperatures higher than 1700°K for TaC and 2700°K for WC, values of C_p and related thermodynamic quantities were extrapolated based on the two Debye parameters: one corresponds to the metal sublattice and the other to the carbon sublattice. The contribution in the total specific heat due to lattice dilation was evaluated using the Nernst-Lindemann relationship. The calculated values of C_p were in good agreement with the experimentally determined values. Furthermore, the calculated values of the absolute entropies at 298.15°K were 5.03 and 4.15 in comparison with the experimental values of 5.05 and 4.15, all expressed in units of cal/og-atom. Using the same Debye parameters, values of the linear coefficients of thermal expansion for TaC and WC were calculated from absolute zero to their respective melting points using the Grüneisen equation. The calculated values are in excellent agreement with the experimental values available in the literature. The values of the bulk modulus of TaC from room temperature to temperature near its melting point were also calculated using the equation recently derived by Anderson. No comparison between the calculated and experimental values can be made due to lack of experimental data. (auth)

11057 CRITICAL SURFACE TENSION OF URANIUM DIOXIDE. Eberhart, J. G. (Sandia Corp., Albuquerque, N. Mex.). J. Nucl. Mater., 25: 105-7(1968).

Wettability is related to liquid surface tension and the dependence of this relation on the chemical nature of the solid surface is shown. (M.C.G.)

11058 THE MECHANICAL PROPERTIES OF SINTERED 316L STAINLESS STEEL. French, P. M.; Mardon, P. G. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Powder Met., 3: No. 4, 65-81(Oct. 1967).

Samples of 316L stainless steel with densities in the range 86 to 98% theoretical have been prepared by powder metallurgical routes and their mechanical properties evaluated. The results have been analyzed on the basis of a uniform distribution of holes in a matrix and compared with predictions from current theories of cermet behavior. At 95% theoretical density—the approximate maximum achievable by a single pressing and sintering operation—the UTS is 85% of that of the fully dense material, but the 0.2% proof stress and elongation values are only 72 and 75%, respectively, of the values for fully dense material. (auth)

11059 STRENGTH CHARACTERISTICS OF GRANULAR ZIRCONIA REFRACTORIES AT TEMPERATURES UP TO 2500°K. Grebenyuk, A. A.; Karaulov, A. G.; Mayauskas, I. S.; Peras, A. Ya. (Inst. of Energetics and Electrotechnics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, 48: 185-93 (1967). (In Russian).

The influence of the monoclinic phase on zirconia strength was tested in a special high temperature apparatus. Under conditions of room temperature it was proved that the increase of the amount of monoclinic phase deteriorate the strength characteristics of refractories. This phenomenon can be explained as follows: the structure of samples with monoclinic phase has many cracks, which size and density increases as the amount of monoclinic phase increases. It was proved that at high temperatures the increase of the amount of monoclinic phase has a positive influence on the strength characteristics of the material, caused by the decreasing of the amount of CaO in the material and a corresponding growth of fireproofness. An increase of the strength of the material was observed at temperatures higher than 2300°K. (auth)

11060 GAS EROSION OF ZIRCONIUM OXIDE CERAMICS. 2. CHANGES UNDERGONE BY SURFACE OF REFRACTORIES MATERIAL. Abraitis, R. I.; Grinyute, G. A.; Mayauskas, I. S. (Inst. of Energetics and Electrotechnics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, 48: 195-202(1967). (In Russian).

Tests were carried out on two refractories based on zirconium oxide. The materials were acted upon by a stream of high temperature gas fumes. The temperature of the walls was kept at 2320°K, the speed of the stream at 500 m/sec. The tests lasted from 0.25 to 10 hours. Being washed by the stream, the surface of the material becomes considerably rougher. During the first hour of the test an intensive evaporation of the material, and separation of various grains were noted. This process affects the upper as well as the deeper layers. The evaporating material is evacuated from the deeper layers through channels formed vertically on the surface. These channels are visible in finegrained material. In roughgrained materials the channels are less visible and have no directional orientation. Selectional evaporation and destruction of various volumes of the material take place in the surface layers. It was observed that crystalites grew vertically to the surface toward the stream. The parameters of their grotes differ from the parameters of the materials not subjected to the test. (auth)

11061 THERMODYNAMIC DESCRIPTION OF THE DISSOLUTION OF CARBON, NITROGEN, AND OXYGEN SOLID PHASES IN NIOBIUM AND TANTALUM. Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals, 14: 113-25(1968). (In German).

The data for thermodynamic calculations in the α-solid solution area of the systems Nb–C, Nb–N, Nb–O, Nb–C–O, Ta–C, Ta–N, Ta–O, and Ta–C–O have been compiled and discussed. In addition, the equilibrium pressures of N_2, CO, O_2, O, NbO, NbO_2, TaO, and TaO_2 over solid solutions of niobium and tantalum are given. From this the importance of the essential engassing and degassification reactions can be estimated at different pressures and temperatures. (auth)

11062 DISPERSION OF METALLIC URANIUM IN URANIUM MONOCARBIDE AND ITS EFFECTS ON THE MECHANICAL PROPERTIES. Val, C.; Trouve, J.; Accary, A. Bull. Soc. Franc. Ceram., No. 73, 33-7(Oct.-Dec. 1966).

Testpieces were obtained by vacuum casting. The Charpy pendulum was used to record impact strength as a function of carbon content. Impact values are maximal at 4.80% of carbon. Above 4.90% of carbon, the impact strength decreases with carbon content increase, but is constant for metallic uranium monocarbide alloys. A correlation between impact strength and metallic impurities is established. The stoichiometric uranium carbide (UC) has the highest impact strength according to test results. (Rev. Met. Lit.)

11063 EFFECT OF ADSORBED SULFATE AND FLUORIDE ON THE DENSITY OF HOT-PRESSED BERYLLIUM OXIDE. Adams, R. B.; Stuart, W. I. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Amer. Ceram. Soc., 50: 685(Dec. 21, 1967).

It is shown that the density of hot-pressed BeO varies with amount of fluoride and sulfate adsorbed. Sulfate adsorbed in the absence of fluoride had a slightly detrimental effect, yielding densities between 93 and 95%, compared with an average density of about 97% for the untreated material. The lower amounts of fluoride also inhibited densification but increasing quantities led ultimately to an improved density of about 99% for 20 to 40 mmole fluoride/mole BeO. The variation of density with amount of added

sulfate–fluoride mixtures gave a complex plot, but a notable feature was the pronounced maximum at 8.5/8.5 mmole/mole with densities approaching 100% theoretical. (M.C.G.)

11064 ELECTRICAL CONDUCTIVITY OF URANIUM DIOXIDE. Bates, J. L.; Hinman, C. A.; Kawada, T. (Battelle Memorial Inst., Richland, Wash.). J. Amer. Ceram. Soc., 50: 652-6(Dec. 21, 1967).

The electric conductivity of nearly stoichiometric single-crystal and polycrystalline uranium dioxide was measured from room temperature to 3000°K. Below approximately 550°K, the curve of log σ versus T^{-1} was linear with a calculated activation energy of approximately 0.17 eV. Between 550 and 1250°K, however, the shape of the curve changed; this change varied from one specimen to another. The electric conductivity increased rapidly with increasing temperature above 1250°K with a change from p-type to n-type conduction. The best linear fit of the log σ versus T^{-1} curve above 1400°K was $\sigma = 3.57 \times 10^3\ e^{-(1.13\ eV/kT)}$. Above 1900°K, the curve deviated slightly from linearity and was best fit by the equation $\sigma = 2.10 \times 10^{-2} T^{1.4}\ e^{-(0.316\ eV/kT)}$. (auth)

11065 VAPOR PRESSURE OF Gd_2O_3 FROM 2350° TO 2590°K. Messier, D. R. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 50: 665-8(Dec. 21, 1967).

Knudsen evaporation experiments were made on gadolinium sesquioxide from 2350 to 2590°K. Two sets of Knudsen cell data yielded average values of 468.7 ± 0.8 and 471.0 ± 0.5 kcal/mole for the assumed evaporation reaction $Gd_2O_3(s) = 2GdO(g) + O(g)$. The results indicate that the evaporation coefficient may be much less than one. (auth)

11066 COMPATIBILITY STUDIES ON UO_2–Nb–H AND UO_2–Ta–H SYSTEMS. Amato, I. (FIAT, Turin). Energ. Nucl. (Milan), 14: 730-2(Dec. 1967).

The compatibility between NbH and UO_2 and between TaH and UO_2 in mixtures was tested by hydrogen sintering. Data reflecting the influence of heat treatment and composition on the diameter of uranium dioxide granules obtained during sintering are tabulated. (J.C.W.)

11067 THE YOUNG'S MODULUS OF CARBON AND GRAPHITE ARTIFACTS. Mason, I. B.; Knibbs, R. H. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon, 5: 493-506 (Nov. 1967).

Measurements of dynamic Young's modulus were made over the temperature range –196 to 1000°C on specimens of British nuclear-grade carbon heat treated at temperatures between 1200°C and 3000°C. The results are discussed in terms of the uniform stress model for graphite, whereby the elastic modules depends essentially on the effective C_{44} shear stiffness of the single crystal, on the orientation of crystallites, and on the artefact porosity. Dislocations lying in the basal plane reduce the effective C_{44} to values below that expected for the lattice alone. This effect is dependent on temperature because of the thermal unpinning of dislocations, and on crystallite size. It is deduced that the lattice value of C_{44} is 4.5 times higher for material treated at 3000°C than for material treated only at 1200°C. The rise of modulus with temperature, occurring above 300°C, is attributed to a process of void-filling determined by the difference between the volume thermal expansion coefficients of artefact and constituent crystallites. The effect of these voids is to reduce the modulus measured at room temperature by a factor of about five for material treated at 3000°C. (auth) (UK)

11068 THERMAL PROPERTIES OF COMPOSITIONS IN THE SYSTEM, UO_2–ZrO_2–CaO. Kern, R. S. (Phillips Petroleum Co., Idaho Falls, Idaho); Beals, R. J. Amer. Ceram. Soc. Bull., 46: 1154-9(Dec. 7, 1967).

The power burst facility (PBF) is a flexible, multipurpose nuclear reactor designed to provide high neutron fluxes during short-period power excursions. The parent core is composed of a fuel composition in the system UO_2–ZrO_2–CaO. High performance requirements imposed on this fuel required a limited testing program to establish out-of-pile and in-pile characteristics. Results of out-of-pile thermal tests on selected fuel compositions to determine the phase stability at elevated temperatures, melting point, specific heat, thermal conductivity, and volumetric expansion of the materials are presented. The range involved was from 1000 to 2450°C. Compositions between 35 and 70 molecular % urania were investigated. Data on in-pile tests in TREAT Reactor are also included. Phase behavior following cycling tests over a wide range up to 3000°C is discussed. (auth)

11069 PRECIPITATION FROM SUPERSATURATED NIOBIUM–OXYGEN–NITROGEN SOLID SOLUTIONS. Gebhardt, Erich; Rothenbacher, Rolf; Kvernes, Ingard (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 58: 790-9(Nov. 1967). (In German).

The precipitation from homogeneous niobium-oxygen-nitrogen solid solutions was investigated using light and electron microscopy. The oxygen content of the specimens was usually about 3.8 at. % and the nitrogen content about 0.4 at. % in the solid solution. On aging at 850°C the hardness of the specimens decreases considerably after a few minutes. However, isothermal hardness measurements at 200 to 150°C and at times up to 80 min indicate pronounced age hardening. At intermediate annealing temperatures two consecutive maxima were observed in the hardness curves. After all annealing conditions employed the specimens appeared homogeneous in the light microscope. The precipitates were visible only after annealing for >2 hours at 450°C. Initially only nitrides are precipitated along grain boundaries and within the matrix. Subsequently, oxide precipitates are also observed. Above 650°C oxide particles were observed only in the grain boundaries, whereas below 650°C rod or plate shaped oxide particles with a preferred orientation occur within the grains. The nitrides which were precipitated in early stages were enveloped by the oxides precipitated later on. Electron microscopic investigations indicated that annealing of the supersaturated niobium-oxygen-nitrogen solid solutions at 200 to 450°C, for <80 min produced coherent particles which gave rise to age hardening. It can be assumed that the first increase in hardness is due to zones I containing essentially nitrogen and that on prolonged annealing these zones are enriched in oxygen. By this process zones I are transformed into zones II which grow up to a critical size (second hardness maximum) and lose their coherency. These incoherent particles can be operative as nucleation sites for a consecutive bainitic precipitation of oxide. The nitride precipitates on dislocations and within the grains observed after prolonged annealing appear to have little effect on the age hardening behavior. (auth)

11070 COMPOSITE MATERIALS. Lectures Delivered at the Institution of Metallurgists Refresher Course, November 1965. New York, American Elsevier Publishing Company Inc., 1967. 160p. $7.50.

The theory of strengthening of metals, dispersion-strengthened materials, fiber-strengthened materials, and the potential of composite materials are discussed. (M.C.G.)

Structure and Phase Studies

Refer also to abstracts 10984, 10986, and 11046.

11071 (ORNL–3795(Pt.5)) A BIBLIOGRAPHY ON TRACER DIFFUSION IN METALS: PART V. SELF AND IMPURITY DIFFUSION IN SIMPLE METAL OXIDES. Askill, John (comp.) (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Frequently factors and activation energies for self and impurity diffusion in simple metal oxides have been compiled from the literature reported up to December 1966. An author index is included. (auth)

11072 (ORNL–TM–2015) INVESTIGATION OF CERTAIN TERNARY SYSTEMS CONTAINING THORIUM AND URANIUM. Venard, John Thomas (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 89p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Potential advantages of thermal-breeder fuels having a metallic thorium matrix with a dispersion of either (Th,U)C or (Th,U)N led to an investigation of the Th–U–C and Th–U–N ternary systems. This investigation was limited to the 1000°C isotherm at 50 atomic per cent carbon or nitrogen and below. Alloys in the Th–U–C system were made by arc-melting techniques while those in the Th–U–N system were prepared by powder metallurgical techniques. Equilibration times for cast alloys in the Th–U–C system were found to be 240 to 350 hours at 1000°C and greater than 1000 hours at 600 and 800°C. In the Th–U–N system the 1000°C equilibration time was found to be 80 to 100 hours. Lattice parameters across the UC–ThC pseudobinary showed a slight negative deviation from Vegard's law and excellent agreement with published data. Across the UN–ThN pseudobinary lattice parameters obey Vegard's law. The most uranium-rich compounds in equilibrium with metallic thorium were found to be $(Th_{0.906}U_{0.094})C_{0.712}$ and $(Th_{0.944}U_{0.056})N_{0.885}$, respectively. A thermodynamic analysis was shown to be consistent with the experimental results and yielded an estimate of the 1000°C free energy of formation of ThN. This value was found to be minus 51,900 calories per gram-mole. (auth)

11073 (SC–RR–66–2624) SHOCK-WAVE COMPRESSION OF POROUS CARBON. Board, R. R. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. 41p. Dep. CFSTI.

In a study of shock compression of two foamed carbons, with initial densities of 0.55 and 0.68 gm^3, conventional high-explosive techniques were used to obtain Hugoniot equation-of-state data up

to pressures of about 200 kilobars. The data for each of the foams appear to fall into two distinct regions. The lower pressure regions have been interpreted as regions where phase transitions are taking place or where compression of the foams to nonporous states is not complete. The higher pressure regions are then regions where phase transitions are complete and where compression to nonporous states are complete. Grüneisen's parameter, γ, has been estimated for the higher pressure regions. (auth)

11074 STUDIES OF THE SYSTEMS OF RARE EARTH SESQUIOXIDES–BERYLLIUM OXIDE: EQUILIBRIUM AND METASTABLE EQUILIBRIUM RELATIONSHIP IN THE SYSTEM Gd_2O_3–BeO. Han, Wen-lung; Kuo, Chu-kun (Inst. of Chemistry and Tech., Shanghai). K'o Hsueh T'ung Pao, 17: 13-15(Jan. 15, 1966).

To investigate the possibility of compound formation between rare earth sesquioxides and beryllium oxide, the phase equilibrium relations of the Gd_2O_3–BeO system were studied. The phase equilibrium diagram of the Gd_2O_3–BeO system, as determined by the quenching method together with microscopic and x-ray powder examination of the quenched samples, is shown. It is a simple binary system with 1 eutectic point at 1472 ± 2°C at 53.4 mole% $GdO_{1.5}$. A new crystalline phase in this system, which is biaxial, was identified, with 2 V ≃ 90°. The refractive indices were determined to be: $n_{fg} = 1.89$, $n_g = 1.94$. The x-ray powder diffraction pattern is shown, together with those of beryllia and Gd_2O_3 for comparison. This new phase is metastable. It does not have a stable phase field in the phase diagram of the Gd_2O_3–BeO binary system. In the quenched samples containing 40 to 60 mole% $GdO_{1.5}$ the content of the new phase appeared to be the most abundant. A single phase of crystals with wavy extinction could be obtained in quenched samples containing 50 mole% $GeO_{1.5}$. The optical properties and unit cell dimensions of this new phase show a close resemblance to those of $La_2O_3 \cdot 2BeO$; it is thus probabe that it has a chemical composition represented by $Gd_2O_3 \cdot 2BeO$. (BBB)

11075 DEFORMATION STUDIES OF THERMOCHEMICALLY DEPOSITED TUNGSTEN SHEET. Spruiell, J. E.; Shuler, B. F.; Patterson, F. H. (Oak Ridge National Lab., Tenn.). Trans. Met. Soc. AIME, 239: 1763-7(Nov. 1967).

The microstructures and textures developed by the working of high-purity thermochemically deposited tungsten sheet have been investigated. Greater than 60% reduction was required to destroy the columnar grain structure which existed in the as-deposited sheet. With increasing reductions the texture gradually changed from the initial as-deposited orientation with ⟨100⟩ parallel to the sheet normal to a {100}⟨011⟩ ideal orientation with some spread about the rolling direction. This texture was retained after recrystallization at 2000°C. (auth)

11076 CONSTITUTION OF NIOBIUM (COLUMBIUM)–MOLYBDENUM–CARBON ALLOYS. Rudy, E.; Brukl, C. E.; Windisch, St. (Aerojet-General Corp., Sacramento, Calif.). Trans. Met. Soc. AIME, 239: 1796-1808(Nov. 1967).

The ternary-alloy system Nb–Mo–C was investigated by means of x-ray, melting point, DTA, and metallographic techniques; a complete phase diagram for temperatures above 1500°C was established. Above 1960°C, niobium monocarbide and the cubic (B1) high-temperature phase in the Mo–C system form an uninterrupted series of solid solutions. The ternary range of the pseudocubic η MoC_{1-x} is very restricted. Dimolybdenum carbide dissolves up to 44 mole % Nb_2C (2240°C), whereas the maximum solid solubility of Mo_2C in Nb_2C does not exceed 5 mole %. The order-disorder transformation temperatures in Mo_2C and Nb_2C are lowered by the mutual metal exchanges. Six invariant (p = const) reactions occur in the ternary system; three correspond to class II-type four-phase reactions involving a liquid phase, one to a class I (eutectoid)-type, and two further isotherms are associated with limiting tie lines. The results of the phase diagram investigation are discussed, and the thermodynamic interpretation identifies the low relative stability of the binary subcarbides in conjunction with the large stability differences between niobium and molybdenum carbides as the cause for the formation of a stable equilibrium between the monocarbide and the metal phase in the ternary region. (auth)

11077 GRAIN-BOUNDARY SEGREGATION AND FINAL-STAGE SINTERING OF Y_2O_3. Jorgensen, P. J.; Anderson, R. C. (General Electric Co., Schenectady, N. Y.). J. Amer. Ceram. Soc., 50: 553-8(Nov. 21, 1967).

The addition of ThO_2 to Y_2O_3 inhibits grain growth during sintering and allows the sintering process to proceed to theoretical density by maintaining a high diffusion flux of vacancies from the pores to the grain boundaries. The inhibition of grain growth is accomplished by the segregation of ThO_2 solute at the grain boundaries, causing a decrease in the grain-boundary mobility. The segregation of ThO_2 at the grain boundaries can be inferred from the results of the microhardness and grain-growth studies presented. Further evidence for segregation is provided by quenching experiments and surface activity experiments. (auth)

11078 CONTRIBUTION TO THE STUDY OF ZIRCONIUM–OXYGEN ALLOYS. Dubertret, A.; Debuigne, J.; Lehr, P. Mem. Sci. Rev. Met., 64: 895-905(Oct. 1967). (In French).

A study was made of the properties of zirconium-oxygen solutions. The anomalies in the changes of the physical properties of the solutions, especially their hardness, are probably connected with the existence of several types of superstructure. It is difficult to reveal these ordered structures by x-ray techniques owing to the low diffusion factor of oxygen. (tr-auth)

11079 CRYSTALLITE SIZE MEASUREMENTS ON THORIA GEL. Bannister, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Amer. Ceram. Soc., 50: 619-23(Nov. 21, 1967).

As part of a detailed study of the sintering behavior of thoria gel, the crystallite size distribution in the gel was measured by electron microscopy. The distribution is in quantitative agreement with BET surface area and x-ray crystallite size measurement, and x-ray diffraction line profiles calculated using the measured size distribution agree with experiment. The relative accuracies of the integral and half-maximum intensity breadth techniques, and the relation between the size distribution and the crystallite size measured by each technique are discussed. Some implications of this work to the sintering study are mentioned. (auth)

11080 HOLMIUM–HYDROGEN SYSTEM. Perkins, F. C.; Lundin, C. E. (Univ. of Denver). J. Electrochem. Soc., 115: 21-4(Jan. 1968).

Pressure-temperature-composition data were obtained to study the nature of the holmium-hydrogen system. A Sieverts-type apparatus was employed to perform measurements at 250 to 950°C, in the composition range, Ho to HoH_3, and at pressures from 10^{-4} to 630 Torr. The existence of three homogeneous phases was established: holmium solid solution, the dihydride, and the trihydride phases. The limits of hydrogen solid solution in each of the phases were determined from discontinuities in the isothermal plots. Equilibrium plateau decomposition relationships were determined from van't Hoff plots in the two-phase regions. The differential heats of reaction in these two regions are, $\Delta H = -52.7 \pm 0.2$ kcal/mole of H_2 and $\Delta H = -18.7 \pm 0.2$ kcal/mole of H_2, respectively. The differential entropies of reaction are, $\Delta S = -35.6 \pm 0.2$ cal/deg·mole of H_2 and $\Delta S = -28.6 \pm 0.4$ cal/deg·mole of H_2, respectively. Relative partial molal and integral thermodynamic quantities were calculated for the system. The dissociation pressure equation for the holmium solid solution dideuteride plateau region was determined for comparison purposes. The enthalpy of reaction to form the dideuteride phase in $\Delta H = -52.3 \pm 0.3$ kcal/mole of D_2, and the entropy of reaction is $\Delta S = -35.8 \pm 0.3$ cal/deg·mole of D_2. (auth)

11081 PHASE EQUILIBRIUM IN SYSTEMS WITH MONOXIDES OF SAMARIUM, EUROPIUM, AND SILICON. Bondar, I. A.; Toropov, N. A.; Koroleva, L. N. Izv. Akad. Nauk SSR, Neorg. Mater., 3: 2034-9(Nov. 1967). (In Russian).

Methods for the synthesis of silicates of bivalent rare earth elements were developed. On the basis of the pyrochemical, crystallographic, x-ray, and spectral data, the phase equilibrium in the SmO–SiO_2 and EuO–SiO_2 systems was established. In the system SmO–SiO_2, two compounds were detected, Sm_4SiO_4 and $SmSiO_3$; four compounds were found in the EuO–SiO_2 system, Eu_2SiO_5, Eu_2SiO_4, $Eu_2Si_2O_7$, and $EuSiO_3$. (tr-auth)

11082 THE SINTERING KINETICS AND POWDER PROPERTIES OF MgO AND UO_2. Krauth, A. (Max-Planck-Institut fuer Silikatforschung, Wuerzburg, Ger.). Ber. Deut. Keram. Ges., 44: 554-9(Nov. 1967). (In German).

The effect of the initial activity on consolidation and grain growth was studied in stoichiometric MgO and in non-stoichiometric UO_2. By activity is understood the fineness of the powder with regard to its crystallite size, particle size, and BET surface area. It was established that both the consolidation mechanism and the rate of compaction were influenced by the initial activity. In grain growth the rate but not the mechanism was affected, so that in this way some control can be exercised over the texture. Various compaction and grain growth rates can be explained by the varying grain densities which arise from powders with different initial activities. (auth)

11083 PHASE DIAGRAMS OF THE SYSTEM, URANIUM–OXYGEN–CARBON. Knacke, Ottmar; Krahe, Josef; Mueller, Franz (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Z. Metallk., 58: 814-20(Nov. 1967). (In German).

Phase diagrams of the systems uranium-oxygen, uranium-carbon and uranium-oxygen-carbon were established using thermochemical data and values from equilibrium measurements. The diagrams show the phase fields of the compounds as a function of the temperature, the partial pressure p_{O_2}, the uranium and carbon activities, and the partial pressure p_{CO}, respectively. The analytic relations for the phase boundaries are given in tabular form. The thermodynamic stability of the phases in the presence of various gases and gas mixtures is discussed as indicated by the diagrams. In particular, the preparation of some phases and their behavior under the chemical conditions in a nuclear reactor are considered. (auth)

11084 COMMENT ON THE DEFECT STRUCTURE OF $\alpha - Nb_2O_5$. Kofstad, P. (Battelle Memorial Inst., Columbus, Ohio). J. Less-Common Metals, 14: 153-5(1968).

The defect structure in $\alpha - Nb_2O_5$ was investigated and found to be qualitatively similar to that of rutile (TiO_2) which has been interpreted to comprise doubly charged oxygen vacancies and trivalent and tetravalent interstitial titanium ions. (F.S.)

11085 DEFECT STRUCTURE MODEL FOR NONSTOICHIOMETRIC CeO_2. Kofstad, P.; Hed, A. Z. (Battelle Memorial Inst., Columbus, Ohio). J. Amer. Ceram. Soc., 50: 681-2 (Dec. 21, 1967).

A defect structure model is proposed which accounts for the observed behavior at large deviations from stoichiometry. For $Ce_{1+y}O_2$ it was assumed that the predominating defects at $y > 0.005$ are singly and doubly charged interstitial cerium atoms. Each interstitial has 6 nearest-neighbor Ce ions on normal lattice sites and the interstitial cations may be proposed to block $6(1-\alpha)y$ normal Ce sites for occupancy by electrons where α is the relative probability of a neighboring Ce site being occupied by an electron. (M.C.G.)

11086 THERMAL DECOMPOSITIONS AND PHASE IDENTIFICATION IN THE ZrO_2–CaO–P_2O_5 SYSTEM. Bremser, Albert Heinrich. Urbana, Ill., Univ. of Illinois, 1967. 70p. Thesis.

The thermal decomposition of $Zr_2P_2O_7$, $(ZrO)_2P_2O_7$, and $CaZr(PO_4)_2$ was investigated. Phase identifications were also made in the high ZrO_2 portion of the $ZrO_2-CaO-P_2O_5$ system after selected compositions had been heated to high temperatures. Over the temperature range of 1450 to 1700°C the compounds ZrP_2O_7, $(ZrO)_2P_2O_7$, and $CaZr(PO_4)_2$ were found to decompose, expelling P_2O_5 as a vapor, according to first order reaction kinetics. Quantitative data for the rate of decomposition of these compounds at various temperatures were obtained. Decomposition of $CaZr(PO_4)_2$ took place only above its melting point, which was found to be about 1320°C and incongruent in character. The compound $Zr_2(PO_4)_4$ was found to exist, although there were indications that it is metastable. The $ZrP_2O_7-CaZr(PO_4)_2$ join was characterized by a eutectic at 1180°C, but no eutectic was found in the join between ZrO_2 and $CaZr(PO_4)_2$. In most cases, where ZrO_2 was identified as one of the final phases after heating the compositions to high temperatures, it was in the monoclinic form. Cubic zirconia was found only in regions where the content of the P_2O_5 was low and that of the CaO high. Based on the results obtained, some statements were made with respect to the behavior that might be expected of phosphate-bonded calcia-stabilized zirconia in refractory applications. (Disser. Abstr.)

Radiation Effects

Refer also to abstracts 10284, 11018, 11046, and 11493.

11087 (AI-CE-76) HEAVY WATER ORGANIC COOLED REACTOR. POSTIRRADIATION EXAMINATION OF THE SAP-UC FUEL BUNDLES OF THE NRU-305 EXPERIMENT. Golding, T. A.; Krupp, W. E. (Atomic International, Canoga Park, Calif. Combustion Engineering, Inc., New York). Dec. 1, 1967. Contract AT(38-1)-430. 52p. Dep. CFSTI.

The U-305 Experiment was conducted to evaluate SAP-UC and Zircaloy-UO_2 fuel systems for the HWOCR program. The U-305 was irradiated in the NRU Reactor at Chalk River, Ontario, Canada, to peak UC fuel burnup near 10,000 MWd/mtU and was removed due to defects in the Zircaloy-UO_2 portion of the experiment. The postirradiation examination of SAP-UC Bundle LTA, which experienced the highest burnup is described. Bundle LTA was disassembled and all fuel rods were subjected to visual examination, fission gas and gamma scan measurements, fouling film sampling, and profilometer measurements. Four fuel rods were destructively examined, including disassembly, visual examination of declad fuel and cladding inner surface, measurement of fuel growth and absolute burnup, and fuel and cladding metallography. No conclusive evidence of defects or radiation-induced degradation was observed in the SAP-UC. The SAP-UC fuel system demonstrated satisfactory operation at the temperature and burnup levels experienced in the U-305 Experiment. (auth)

11088 (BNWL-536) STOICHIOMETRY EFFECTS IN OXIDE NUCLEAR FUELS. I. POWER RATING REQUIRED FOR MELTING AND OXYGEN REDISTRIBUTION IN MOLTEN CENTER $UO_{2\pm x}$ FUELS. Christensen, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 107p. Dep. CFSTI.

Effects of departures from stoichiometry on heat transfer in $UO_{2\pm x}$ ($-0.10 \leq x \leq 0.15$) were measured by irradiation experiments employing partially molten fuel specimens. Redistribution of excess oxygen or uranium was measured following irradiation. (auth)

11089 (GA-7100) ADVANCED GRAPHITE FUEL SYSTEMS. Annual Report, May 15, 1965–May 14, 1966. Bokros, J. C.; Engle, G. P.; Goeddel, W. V.; Price, R. J.; White, J. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 1, 1967. Contract AT(04-3)-167. 93p. Dep. CFSTI.

Irradiation of molded binder-filer artifacts containing various fillers and pitch contents has been completed, and property measurements have begun. Results on dimensional changes show that these effects are temperature-dependent at 900 to 1450°C. Micrographic studies have been made on binder-filler artifacts which were molded at 120°C, baked at 500°C, and heat-treated to temperatures between 550 and 900°C. Isochronal annealing experiments have been started on carbons irradiated in capsule G9 and carbons containing Co-deposited titanium. The relation between the structure of pyrolytic carbon and its behavior under irradiation is being investigated by measuring dimensional, physical, and mechanical property changes of pyrolytic carbons. The relation between radiation-induced length changes and preferred orientation in polycrystalline graphite has been investigated by measuring the pre- and post-irradiation dimensions of samples which were cut from an extruded graphite tube and had different preferred orientations. Investigations relating the preferred orientation and thermal expansion of non-graphitic carbons indicate a systematic dependency between the two variables similar to that observed for well-crystallized graphite. The feasibility of measuring the damage effects of fission-recoil atoms is being studied in which a dense isotropic carbon strip was bombarded with fission-recoil atoms at ~1200°C. (J.C.W.)

11090 (NUMEC-3432-24) PERFORMANCE OF COPRECIPITATED AND MECHANICALLY BLENDED 5 w/o PuO_2–UO_2 FUELS AFTER IRRADIATION TO 10,000 AND 20,000 MWD/Tonne. AEC Research and Development Report, July 1, 1965–June 30, 1966. (Nuclear Materials and Equipment Corp., Leechburg, Pa. Plutonium Lab.). Dec. 1967. Contract AT(30-1)-3432. 83p. Dep. CFSTI.

Thermal recycle fuels containing 5 wt % PuO_2-UO_2 pellets prepared from coprecipitated and mechanically blended oxides were fabricated into test elements and irradiated in the GETR. The performance of these fuels was evaluated from the standpoint of powder preparation routes, pellet oxygen/metal ratio, and the effects of inhomogeneities in mechanically blended fuel. Combinations of blending, milling, and sintering treatments were employed to achieve solid solution mixed oxide. Two sintering conditions were used to obtain both stoichiometric and substoichiometric pellets. For the homogeneous fuels, substoichiometric coprecipitated and mechanically blended oxides with an O/M ratio of 1.98 were prepared by sintering pellets in dry $N_2-6\%$ H_2 at 1600°C. Stoichiometric mechanically blended oxides were prepared by sintering pellets in moist $N_2-6\%$ H_2 at 1600°C. The inhomogeneous mechanically blended fuels were sintered in dry $N_2-6\%$ H_2. Fuel elements consisting of 0.20 inch diameter pellets clad in 0.202 ID × .019 inch wall Type 316L stainless steel were irradiated at a peak heat generation rate of 10 kW/ft with clad temperatures of 600°C to burnups of 10,000 and 20,000 MWd/t. Coprecipitated and mechanically blended fuels having the same substoichiometric O/M ratio showed excellent in-pile behavior. After 10,000 MWd/t burnup, the homogeneous stoichiometric mechanically blended fuels released twice as much fission gas as the substoichiometric fuels, 42 versus 22% indicating higher central temperature. After 20,000 MWd/t irradiation both substoichiometric and stoichiometric fuels released about the same amount of fission gas, 35 ± 5%. The amount of fission gas released from the inhomogeneous mechanically blended fuels was proportional to the burnup, and reached a maximum of 32% at 250 watts/cm peak heat generation rate for both PuO_2 and 30 wt % PuO_2-UO_2 spherical inclusions. Homogenization occurred in the mechanically blended oxides in accordance with the amount of columnar grain growth and burnup. Stoichiometric mechanically blended fuels were characterized by a central shrinkage void 20 to 30 mils in diameter. The amount

of columnar and equiaxed grain growth observed in stoichiometric mechanical blended fuel when compared to the substoichiometric fuels operating at the same heat generation rate suggests a 15% lower thermal conductivity for the stoichiometric mixed oxide. For exposures representing the mid-life and end-of-life burnup of central station BWR or PWR reactors no significant difference was found in the performance of coprecipitated and mechanically blended fuels. Of the two fabrication processes, mechanically blending would therefore be the most desirable fuel fabrication method for plutonium recycle fuels because of lower overall fabrication cost. (M.C.G.)

11091 (ORNL–4199) IRRADIATION BEHAVIOR OF ALUMINUM-BASE DISPERSIONS CONTAINING EUROPIUM OXIDES. Beaver, R. J.; Richt, A. E.; Martin, M. M. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 51p. Dep. CFSTI.

Three miniature control rod plates were irradiated to investigate the behavior of europium-bearing materials selected as the neutron absorber for the High Flux Isotope Reactor. Two of the aluminum-clad plates contained cores composed of 33 vol % (59 wt %) Eu_2O_3 dispersed in aluminum, the reference neutron absorber material. The third contained an equivalent europium loading as 38 vol % (65 wt %) $Eu_{5.3}MoO_{11}$. All three test specimens had the same cladding-core-cladding thicknesses (0.031, 0.188, 0.031 in.) as the full-size HFIR control plates. The plates were irradiated at 60°C center-line temperature for periods ranging up to one year, resulting in an estimated perturbed thermal-neutron dose of up to 2.9×10^{21} neutrons/cm^2 and a fast neutron dose of up to 1.1×10^{21} neutrons/cm^2 (>1 MeV). Core volume increases were less than 0.3% in the Eu_2O_3-bearing specimens exposed to burnups of 1.6×10^{21} and 4.1×10^{21} neutron absorptions/cm^3. A slightly greater volume increase of 0.8% was observed in the $Eu_{5.3}MoO_{11}$-bearing specimen, which had absorbed 2.9×10^{21} neutrons/cm^3. No evidence of irradiation-induced microstructural changes or loss of structural integrity was observed in any of the three specimens. The type 6061 aluminum cladding hardened from approximately 50 to 100 DPH after a fast neutron (>1 MeV) dose of 4.9×10^{20} neutrons/cm^2. Corrosion tests in water at 100°C indicated that the Al–33 vol % Eu_2O_3 dispersions were less susceptible to hydration and swelling after irradiation than they were before. Both unirradiated and irradiated Al–38 vol % $Eu_{5.3}MoO_{11}$ dispersions resisted water at 100°C. (auth)

11092 BeO–GRAPHITE IN-REACTOR COMPATIBILITY AT 1500°C AND RESULTING ^{6}Li DISTRIBUTION. Brandon, C. A.; Cuneo, D. R.; Engle, G. B.; Long, E. L. Jr. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 4: 23-30 (Jan. 1968). (ORNL-P-3209).

An experimental assembly to study irradiation effects on the compatibility of BeO with graphite at 1500°C held one-inch-diameter rings of BeO and graphite in close contact for 9 months exposure at 1200 to 1500°C for a neutron dose of 1×10^{21} n/cm^2 (E > 0.18 MeV). Postirradiation evaluations indicated that no chemical reaction had occurred. The components of the irradiated assembly were sampled and analyzed for ^{6}Li. It was found that a massive BeO component (1-in.-dia by 4.5-in.-length) retained a major portion of the ^{6}Li which was generated within it during the irradiation. No gross radiation-induced physical damage was observed in either the BeO or the graphite components. The physical changes observed were in general agreement with previously reported results. (auth)

11093 EFFECTS OF COMBINED SPACE RADIATION ON SOME MATERIALS OF LOW SOLAR ABSORPTANCE. Bailin, L. J. (Lockheed Palo Alto Research Lab., Calif.). pp 125-31 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

The refractory material $ZrO_2 \cdot SiO_2$ is discussed as a component of inorganic silicate binder systems, which are stable optically and physically under a variety of ground-simulated space conditions. These systems are finding application as passive thermal control and heat rejection coatings on spacecraft surfaces. The environments discussed are combined ultraviolet-electron, ultraviolet-proton, as well as the corresponding, but separate ultraviolet, electron, and proton environments. Previously determined data on neutron-gamma exposures are also included. For $ZrO_2 \cdot SiO_2$ as a pigment, it is shown that impurity content and temperature of preparation bear strongly on the optical properties, and consequently on the ability to reflect solar radiation and reject heat. The use of very-high-purity starting materials is shown as a requirement to obtain low solar absorptance, α_s, (high solar reflectance), as well as optical stability under ultraviolet radiation. For high-purity pigments, combined UV-p, UV-e exposures, little or no synergism of effects is noted; that is, no greater increases in α_s (no greater discoloration) resulted from the combined exposure than from the UV, p, and e exposures separately. Small changes resulted from the proton and electron exposures, and no direct correlation with purity was noted. For $ZrO_2 \cdot SiO_2$ incorporated into silicate binders, the relations of purity and preparation variables to stability are similar to those for the pigment alone. However, the already high stability of the pigments seems to be enhanced by the binder, and even higher stabilities are achieved. (auth)

11094 REVIEW OF THE STATUS OF SPACECRAFT THERMAL CONTROL MATERIALS. Streed, E. R.; Arvesen, J. C. (Ames Research Center, Moffett Field, Calif.). pp 181-92 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

Engineering applications of various materials used for spacecraft passive temperature control are reviewed. Although selection depends primarily on the thermophysical properties, the influence of solar ultraviolet radiation, electrons, protons, and temperature in a high vacuum environment must be carefully considered. The effects of ultraviolet spectral distribution, particulate (protons and electrons) radiation energy and flux, combined environment synergisms, and oxygen bleaching are presented for typical thermal control materials. Results of laboratory studies and flight stability experiments illustrate the need for more sophisticated simulation techniques to realistically evaluate these materials. Alternate design techniques utilizing new materials are shown to be potentially capable of stable performance for extended missions. (auth)

11095 OUTGASSING OF GLASS BY 100- TO 1000-VOLT ELECTRON BOMBARDMENT. Dawson, P. H. (General Electric Research and Development Center, Schenectady, N. Y.). Nuovo Cim., Suppl. (1), 5: 612-19(1967).

From International Symposium on Sorption–Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

A method for studying the breakdown and outgassing of bulk insulators at low electron energies, by utilizing the secondary-electron-emitting properties of the insulators, is described. The method was applied to the bombardment of glasses with 100 to 1000 volt electrons. Large quantities of oxygen were evolved. Rates of release as a function of electron energy, current density, and time of bombardment were determined. (auth)

11096 THERMAL EXPANSIVITIES AND PREFERRED ORIENTATION OF PYROLYTIC CARBONS. Price, R. J.; Bokros, J. C.; Koyama, K. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Carbon, 5: 423-30(Nov. 1967).

The relation between preferred orientation and thermal expansion coefficient was investigated for a wide variety of pyrolytic carbons, including materials used for free-standing bodies as well as those used for coating nuclear fuel particles. Over most of the range of preferred orientations studied, the data deviated from the simple Bacon relation, indicating that a portion of the crystallite c-axis expansion is accommodated. The amount of accommodation was found to depend on the density of the carbon. A high-temperature lattice parameter determination established that intercrystalline elastic restraints do not contribute significantly to the accommodation. The accommodation is therefore attributed to porosity. The thermal expansion coefficients of a variety of carbons used as coatings for nuclear fuel particles were found to be insensitive to neutron irradiation at 890 to 1060°C exposures of 2.2×10^{21} to 2.4×10^{21} nvt (E > 0.18 MeV). (auth) (UK)

11097 MODEL TO DESCRIBE NEUTRON-INDUCED DIMENSIONAL CHANGES IN PYROLYTIC CARBON. Bokros, J. C.; Schwartz, A. S. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contracts AT(04-3)-167; AT(04-3)-633. Carbon, 5: 481-92(Nov. 1967).

A model is presented that describes the dimensional behavior of pyrolytic carbon during irradiation by fast neutrons. The model uses crystallite averaging methods to describe the anisotropic distortion of the bulk in terms of its preferred orientation and the shape change of the individual crystallites. The densification is assumed to be independent of the shape change and is superimposed isotropically on it. The predictions of the model agree with experimental observations. Strain rates calculated from the model are used to estimate the suitability of various carbon structures for use as coatings on an unyielding support. For example, using a creep constant of 1×10^{-27} (nvt-psi)$^{-1}$ at 1200°C, the model predicts that a carbon with a Bacon Anisotropy Factor (BAF) of 1.2

and apparent crystallite heights (L_c) in the range 120 to 155 Å would not fail due to neutron-induced dimensional changes if its original density were greater than 2.0 g/cm³. Similarly, carbons with the same crystallite size but with BAF = 1.0 would not fail under the same conditions if their original densities were greater than 1.7 g/cm³. (auth)

11098 MECHANICAL PROPERTIES OF REACTOR GRAPHITE. Taylor, R.; Brown, R. G.; Gilchrist, K.; Hall, E.; Hodds, A. T.; Kelly, B. T.; Morris, F. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Carbon, 5: 519-31(Nov. 1967).

The following mechanical properties of three types of isotropic reactor graphite were measured, before and after fast neutron irradiation at 150°C in DIDO: Young's modulus, Poisson's ratio, stress-strain curves in tension and compression, shear strength, uniaxial tensile and compressive strength, triaxial compressive strength, and Vicker's hardness. The propagation of cracks in these graphites was examined microscopically and measurements made of the work of fracture. The accumulation of irradiation damage was followed by measuring changes in linear dimensions of the specimens, and of pyrolytic graphite samples, showing that the graphite is heavily damaged. The experimental data were compared with theories of the mechanical properties of unirradiated and irradiated graphite. A model in which large pores act as "Griffith" flaws is compatible with the data on irradiated graphite, but in unirradiated graphite plastic flow modifies the failure in compression. (auth)

Plastics and Other Materials

Refer also to abstracts 10495, 10512, 11047, 11500, 12035, and 12103.

11099 (AERE-R-5504) PRELIMINARY INVESTIGATIONS INTO THE USE OF GLASS BEADS IN FIBREGLASS REINFORCED PLASTICS. Wells, H. (Atomic Energy Research Establishment, Harwell (England)). July 1967. 24p. Dep. CFSTI. UK 4s. 6d.

The effect of adding glass beads and powdered quartz to resins used for manufacturing Fiberglas laminates is reported. Viscosity considerations make it practicable to use higher loadings of glass beads than powdered quartz, and there appears to be preliminary evidence that the shape of the filler can affect the mechanical properties of the resultant composite. (auth)

11100 (BDX-613-100) FLUIDIZED-BED COATING. Sheeley, J. D. (Bendix Corp., Kansas City, Mo.). Dec. 1967. Revised Dec. 29, 1967. Contract AT(29-1)-613. 92p. Dep. CFSTI.

Work in developing Fluidized-Bed Coating techniques for the application of electrical insulation to the surfaces of three-dimensional shapes ranging in size from a few inches to approximately 30 inches in major dimension is summarized. Objectives are cost-savings and design-flexibility for these and related parts. Polyethylene and Phenoxy are investigated because of dielectric characteristics. Statistical studies are employed to determine optimum process conditions. Experimental results show breakdown-voltages are not consistent. Polyethylene is satisfactory at moderate voltages, but Phenoxy is unsuitable because of crazing. Crazing increases with age. Parts should be individually-dipped. Additional process-study is recommended, together with possible reformulation of Phenoxy and investigation of other materials. (auth)

11101 (GA-7906) ADVANCED GRAPHITE FUEL SYSTEMS. Annual Report, May 15, 1966–May 14, 1967. Bokros, J. C.; Engle, G. B.; Price, R. J.; White, J. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 5, 1967. Contract AT(04-3)-167. 138p. Dep. CFSTI.

Results of research on the structure and properties of carbons and graphites and the effects of irradiation on these structures and properties are reported. Aspects dealt with include structure of carbonized coal-tar pitch, characterization of degree of graphitization, influence of pitch-binder content, thermal expansivity of non-graphitic carbons, radiation-induced changes in dimensions of pyrolytic carbons, annealing studies of pyrolytic carbon structures, and fission-recoil damage to carbons and graphites. Equipment and procedures used in the investigations are detailed. (P.G.C.)

11102 COMMERCIAL ASPECTS OF INSTANTANEOUS RADIATION CURE OF REINFORCED PLASTICS. Brenner, W. (New York Univ.); Oliver, W. F. Reinf. Plast. (London), 11: 294-7; 306(June 1967).

Attention is called to the commercial possibilities of electron-beam-radiation curing for the large-scale production of glass fibre-reinforced polyester plastic parts, at high production rates. The current status of work in this field is reviewed, together with cost estimates and application potentials. Irradiation curing of the following is considered: Wet lay-up glass cloth- and glass mat-reinforced polyester resin laminates; commercially available glass fibre-reinforced polyester prepegs; and commercially marketed glass fibre-reinforced polyester moulding. (UK)

11103 PACKAGING OF IRRADIATED FOODS. Killoran, John J. (Army Natick Labs., Mass.). Mod. Packag., 40: 179-83(Apr. 1967).

Progress in research to establish the safety of flexible packages for irradiated foods is reviewed. In 4 films used in radiation sterilization processing of packaged foods, namely, polyethylene, polyethylene terephthalate, polyvinyl chloride-vinyl acetate, and nylon 6, irradiated to 5.6 Mrad with ^{60}Co no induced radioactivity was found. Chemical effects of radiation on such materials are considered. In some cases crosslinking is observed; in others, chain scission, formation of unsaturated bonds, hydrogen and other gases and, where the irradiation is conducted in the presence of air, oxidation may occur. These changes have a profound effect; e.g., with cross-linking, there is a marked increase in molecular weight, resulting in an increase of tensile and flexural strengths and of the softening point, and a corresponding decrease in elongation, crystallinity, and solubility. Relative stability of various polymeric materials being investigated as candidates for packaged irradiation-sterilized foods is described. Flexible materials, as a whole, are fairly resistant to radiation, except for cellulosics, which are the least radiation resistant of common packaging materials. Five commercially available plastic laminates were screened for in-package radiation-sterilization processing of pork products. One laminate, containing medium-density polyethylene as the food-contacting material, was found satisfactory for packaging and for storage over a year period. Tests of fibreboard components showed that a radiation dose of 6.0 Mrad caused some loss in the protective characteristics of these materials; burst strengths were reduced by 19 to 28%. There is no generally accepted method that can be used to indicate whether a food package has been irradiated and how much radiation has been applied. The packaging material, itself, appears to offer an ideal indicator through such physical or chemical changes as thermoluminescence. (BBB)

11104 SILICONES IN OUTER SPACE. Thorne, J. A.; Whipple, C. L. (Dow Corning Corp., Midland, Mich). pp 243-53 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

Silicone elastomers, resins, and lubricants were characterized for performance in the high vacuum, temperature extremes, and radiation environments of outer space. Much of the general characterization is reported in the literature. Recent studies dealt in greater detail with effects of outgassing from silicone materials on their physical and electrical property retention, adhesive strength, low-temperature performance characteristics, etc. Secondary effects resulting from vacuum exposure, such as the condensation of outgassing by-products on optical surfaces and electrical contacts are discussed. Processing techniques for removal of outgassing species are suggested, and results indicating the effectiveness of these techniques are presented. In addition, methods of collecting and qualitatively determining the chemical composition and origin of the volatile components are also presented. The use of silicone diffusion pump fluids for creating hard vacuums is discussed, as is the use of the fluorosilicone lubricating fluids in mechanical pumps used with man-rated chambers and other vacuum systems where contact with gaseous oxygen, etc., may occur. (auth)

11105 MEASURED EFFECTS OF VARIOUS COMBINATIONS OF NUCLEAR RADIATION, VACUUM, AND CRYOTEMPERATURES ON AEROSPACE ADHESIVES. Lightfood, R. P. (General Dynamics, Fort Worth, Tex.); Kerlin, E. E.; Gause, R. L. pp 279-90 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

Specimens of adhesives likely to be used in spacecrafts utilizing nuclear power were subjected to various environmental combinations of temperature, pressure, and radiation. Tensile-shear tests were performed on the specimens to determine the effects of ambient air irradiation, vacuum irradiation, LN_2 irradiation, and LH_2 irradiation. Special equipment was fabricated at NARF for testing the specimens while in the vacuum and the cryotemperature environments. The adhesives reported are: polyurethane (APCO 1252), epoxy-nylon (FM 1000, Metlbond 406,

Scotchweld Af-40), epoxy-phenolic (Aerobond 422J, Aerobond 430, HT-424), epoxy (Epon 934), and modified epoxy (Narmco A). The specimens received a maximum gamma dose of 1.7×10^{11} ergs/gm(C) and an integrated neutron flux of 2.5×10^{16} n/cm^2 (E > 2.9 MeV). The relative merits of the adhesive classes are discussed in relation to nuclear-rocket applications. (auth)

11106 RADIATION DAMAGE OF EPOXY RESINS USED IN MAGNET COIL INSULATION. Pluym, G.; Van de Voorde, M. H. (CERN, Geneva). pp 341-51 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The main mechanisms by which nuclear radiation interacts with organic materials are discussed. On the basis of molecular structure some factors are deduced which influence the behavior of polymeric materials in a radiation field. The resulting selection criteria were applied on a number of epoxy resins used for coil insulation. Results of changes in mechanical, electrical and physical properties are described. The tests were performed using a nuclear reactor, spent fuel elements, or the proton beam from the CERN Linac. The expected dose during operation of the Intersecting Storage Rings is stated. (auth)

11107 MESOPHASE MICROSTRUCTURES IN CARBONIZED COAL-TAR PITCH. White, J. L.; Guthrie, G. L.; Gardner, J. O. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Carbon, 5: 517-18(Nov. 1967).

Polarized-light micrography was employed to investigate the microstructure of the coalesced mesophase formed in the carbonization of coal-tar pitch. Prominent features in the polarized-light extinction contours are the nodal points which do not move when the plane of polarization is rotated. These nodal points are found to correspond to two types of linear defects in the stacking of the aromatic layer planes. When the mesophase is further carbonized, the nucleation, growth and percolation of gas bubbles cause extensive plastic deformation of the mesophase. This deformation leads to an increasingly fine texture of extinction contours and nodal points. (auth) (UK)

11108 RADIATION-RESISTANT FLUIDS. Hollinghurst, Ralph (to Mobil Oil Corp.). U. S. Patent 3,351,553. July 9, 1963.

A method of lubricating the metal surfaces of equipment exposed to radiation comprises the steps of applying to the metal surfaces a lubricant consisting of about 25% to 95% by weight of a mineral oil normally prone to radiation deterioration and about 75% to 5% by weight of a partially hydrogenated terphenyl. A minor amount of didodecyl selenide may also be added. (TSS)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 10660, 11242, 11247, 11252, 11254, 11259, 11270, 11271, 11273, 11275–11281, 11289, and 11732.

11109 (SC-T-68-1502) THEORY OF ASTRONOMICAL SCINTILLATION. PART II. Elsaesser, H. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Z. Astrophys., 50: 278-95(1960). 25p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Scintillation phenomena are discussed on the basis of a diffraction theory. Starting with a solution of the wave equation by Obuchow, formulae for the rms fluctuation in brightness and direction of visible starlight are derived. Comparison with part I shows that geometrical and wave theory give identical results for the changes in direction (seeing). In the case of the brightness scintillation the geometrical approximation is valid for stars near the zenith, whereas diffraction effects cannot be neglected near the horizon. The variation of scintillation with increasing zenith distance can be explained only by the combined effect of turbulent eddies with various sizes. From the measured dependence of the seeing on the zenith distance it follows that the correlation between the fluctuations in the refractive index and the dimensions of the eddies differ from the lower to the upper atmospheric layers. The increase of the brightness scintillation with zenith distance depends strongly upon the telescope's aperture in accordance with the observations. (auth)

11110 ACCELERATION MECHANISMS OF CHARGED PARTICLES UNDER THE GUIDING-CENTER APPROXIMATION. Sakurai, Kunitomo (Kyoto Univ.). Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku, No. 3, 7-12(Nov. 1966). (In Japanese).

The motion of charged particles in varying electric and magnetic fields is dealt with under the guiding-center (or adiabatic) approximation. The static magnetic field does not change particle energy, whereas the time- and space-dependent magnetic field changes particle energy through either acceleration or deceleration. The electric fields, including the static one, also accelerate or decelerate charged particles similar to the varying magnetic fields. The motion of a charged particle in the varying electric and magnetic fields is calculated, and then the acceleration mechanisms of charged particles are examined. The acceleration of charged particles results from several different acceleration mechanisms, but the two types of spectrum of accelerated particles are reduced in reality since the effectiveness for each of such mechanisms is relatively different from each other. The applications to the acceleration mechanisms of solar cosmic rays and of the energetic electrons responsible for the emission of solar radio type-IV bursts are discussed. (auth) (NSA of Japan)

11111 DETERMINATIONS OF THE DIMENSIONS OF METEORITES BEFORE THEY REACH THE ATMOSPHERE BY MEANS OF THE EFFECTS OF COSMIC RADIATION-INDUCED NUCLEAR REACTIONS. Lavrukhina, A. K.; Ibraev, T. A. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1794-8(Nov. 1966). (In Russian).

A large portion of the meteorites reaching the Earth is lost because of ablation. The author proposed earlier a method to determine the original dimensions of meteorites from the depth-wise distribution of nuclear-active particles and cosmic isotopes resulting from the nuclear interactions of cosmic rays with the matter of the meteorites. The method involves the selection of pairs of isotopes with similar half-lives and different excitation functions; one of these isotopes is formed primarily by cosmic rays and therefore its formation decreases with increasing depth r_i and increasing radius R_i of the original meteorite. The primarily neutron-generated other isotope increases up to a threshold value of r_i and R_i, decreasing after having reached this value. The pairs chosen include ^{22}Na and ^{49}V or ^{54}Mn, ^{26}Al and ^{53}Mn. The problem was further studied by examining the effect of the charge of the intensity and shape of the energy spectrum of primary cosmic rays on the precision of the measurements. It was found that both of these factors effect strongly the calculated value of the radius, the depth, and the original weight before ablation. The new formula allows calculation more precisely of the ablation and the amount of cosmic matter reaching the surface of the earth. (TTT)

11112 EARLY HISTORY OF COSMIC RAYS IN THE SOLAR SYSTEM. Lavrukhina, A. K. (Inst of Geochemistry and Analytical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1747-54(Nov. 1966). (In Russian).

Meteorites represent our most important source of information about the early history of matter in the solar system because their structure and composition preserve the effects of various cosmic events since the solidification of matter. Study of the depth distribution of radioactive products with various half-lives resulting from nuclear reactions in iron meteorites revealed with an accuracy of 50% that the intensity of primary cosmic radiation remained constant for the last few millions of years. This work was based on the distribution curve of the rate of formation of ^{22}Na and ^{49}V in iron meteorites of various dimensions. Determination of ^{40}K in iron meteorites and in the ferrous phases of the stony ones makes it possible to estimate the cosmic radiation activity for periods ranging from 1 million to several billion years. The isotopic composition of lithium, boron, xenon, etc. served as an indicator for studying earlier solar flares. From data on the inert gas content of the various phases of materials it was concluded that most of these gases were trapped by the original matter because of the action of a strong "solar wind." (TTT)

11113 LUMINESCENT PROPERTIES OF ROCKS, METEORITES, AND NATURAL GLASSES UNDER PROTON BOMBARDMENT. Blair, I. M. (Atomic Energy Research Establishment, Harwell, Eng.); Edgington, J. A. Nature (London), 217: 157-60 (Jan. 13, 1968).

Suggestions that some transient lunar events are luminescent phenomena excited by solar protons have aroused interest in the luminescent properties of possible lunar surface materials. This communication describes a study of the luminescence produced in various minerals and meteorite materials by a beam of 146-MeV protons, at a flux of about 10^8 protons/sec/cm^2. This flux, and the associated ionization density, are considered to simulate conditions on the Moon's surface more closely than those employed by other workers, and to avoid problems of radiation damage. Spectra were obtained between 3800 and 7400 Å at −180°C, +20°C, and +100°C. A study was also made of thermoluminescence produced by irradiation at −180°C, followed by heating to +180°C. For geological samples the luminescent intensities were in all cases similar at +20°C and +100°C, but were greatly enhanced at −180°C. For meteorites it was found that some classes were brighter at +100°C than at −180°C (unlike any terrestrial rocks studied), and showed thermoluminescence near to or above room temperature. The Barwell meteorite appeared to be anomalous in its luminescent properties. The tektites and terrestrial glasses examined showed only small low-temperature enhancement, and no thermoluminescence; an exception was the Moldavite tektite, which showed a total light output about five times that of the others studied. Granites showed intense thermoluminescence, and this suggests an explanation of the transient red glow seen in regions of the moon believed to be prone to tectonic disturbances. It may sometimes happen that cold subsurface material, possibly granite, is suddenly disturbed and exposed to surface insolation; a previous history of low temperature irradiation may then give rise to visible thermoluminescence. (UK)

11114 IDENTIFICATION OF ^{244}Pu FISSION TRACKS AND THE COOLING OF THE PARENT BODY OF THE TOLUCA METEORITE. Fleischer, R. L.; Price, P. B.; Walker, R. M. (General Electric Co., Schenectady, N. Y.). Geochim. Cosmochim. Acta, 32: 21-31(Jan. 1968).

Fossil nuclear fission tracks were studied in three silicate minerals from inclusions in the iron meteorite Toluca. If most of these tracks are assumed to be due to ^{244}Pu, their densities relative to those from ^{238}U spontaneous fission give measures of the time intervals between the end of production of heavy elements that were condensed in the solar system and the times when the minerals reached temperatures below which fission tracks are permanently stored. These time intervals, together with track stability data, allow a cooling rate of $1.1^{+0.4}_{-0.3}$ °K/million yr to be calculated through the temperature interval 500 to 900°K, 4.6 billion yr ago. This cooling rate agrees with that previously inferred by a totally different technique. The fission tracks are thus concluded to be due to ^{244}Pu, the only known spontaneously fissioning isotope which would yield the observed concordant cooling rate. (auth) (UK)

11115 NOBLE GASES IN UNEQUILIBRATED ORDINARY CHONDRITES. Heymann, D.; Mazor, E. (Univ. of Chicago). Geochim. Cosmochim. Acta, 32: 1-19(Jan. 1968).

The rare gases were determined mass spectrometrically in eleven unequilibrated ordinary chondrites. The amounts of primordial Ar, Kr, and Xe are systematically greater than in

ordinary chondrites proper. Primordial Ne was detected in only two of the meteorites. The amounts of the heavy rare gases Ar, Kr, and Xe are approximately inversely proportional to the degree of equilibration of Fe in olivine, and are directly proportional to C contents. The primordial rare gas constants of different pieces of Bishunpur, Krymka and Mezö-Madaras vary substantially, indicating that these meteorites are inhomogeneous in this respect. The heavy gases Ar, Kr, and Xe are "planetary" in the sense of the model of Signer and Suess. The average primordial $^{36}Ar:^{38}Ar$ ratio in nine cases is 5.35 ± 0.15. Except for ^{129}Xe, the Xe isotopic composition agrees with that of "average carbonaceous chondrites." Carbonaceous chondrites, unequilibrated ordinary chondrites, and ordinary chondrites proper form a sequence of decreasing contents of primordial rare gases of the "planetary" type. This is consistent with a recent theory by Larimer and Anders on the formation of these meteorites. It is inferred from the results that neon does not belong to the "planetary" component. (auth) (UK)

11116 EVIDENCE FOR X RADIATION FROM THE RADIO GALAXY M87. **Bradt, H.; Mayer, W.; Naranan, S.; Rappaport, S.; Spada, G. (Massachusetts Inst. of Tech., Cambridge). Contracts NSR 22-009-129; AT(30-1)-2098. Astrophys. J., 150: L199-206(Dec. 1967).**

During a recent sounding rocket flight, a survey of the Virgo Cluster of galaxies was carried out in the x-ray region, 1.5 to 6 keV. Large-area detectors with slat collimators of 2° FWHM yielded two crossing celestial lines of position for each detected source. The radio galaxy M87 and the quasar 3C 273 were viewed from sufficiently high altitude so that atmospheric absorption was negligible. In the 500 sq. degrees scanned around the Virgo Cluster, only one source was detected. Its most probable celestial position is ½° from M87, well within the measurement uncertainty of 6.5 sq degrees. The intensity of this source is consistent with that of the source reported previously, and identified as M87, by the NRL group. No signal was observed from 3C 273. (W.D.M.)

11117 COMMENTS ON A PAPER BY COHEN ET AL. **Hewish, A.; Little, L. T. (Cambridge Univ., Eng.). Astrophys. J., 150: L195-7(Dec. 1967).**

In their paper Cohen, Gundermann, Hardebeck, and Sharp (1967) criticized some of the author's earlier work and have suggested that the observed reduction of scintillation index close to the Sun is due, not to simple diameter blurring of the diffraction pattern, but to effects arising from the finite thickness of the scattering region. The anthors do not believe this criticism to be valid since it relies, among other things, upon a considerable overestimate by Cohen et al. of the total phase modulation imposed by the interplanetary plasma. (W.D.M.)

11118 PARALLAX AND PROPER MOTION OF THE PYGMY SUSPECT LP 9-231. **Riddle, R. K.; Klugh, A. P. (Naval Observatory, Washington, D. C.). Astrophys. J., 150: L193(Dec. 1967).**

A preliminary parallax and proper-motion solution is presented for the star LP 9-231. The observational results are summarized. On the basis of these astrometric data as well as the photometric and spectroscopic data given by Eggen and Sandage (1967), it is concluded that LP 9-231 is not a pygmy star, but is instead a high-velocity white dwarf. (W.D.M.)

11119 COSMIC X-RAY SURVEY IN THE SOUTHERN HEMISPHERE. **Cooke, B. A.; Pounds, K. A.; Stewardson, E. A.; Adams, D. J. (Univ. of Leicester, Eng.). Astrophys. J., 150: L189-91(Dec. 1967).**

An unstabilized skylark rocket (SL 118) was launched from Woomera at 20.20 local time on April 10, 1967. The rocket carried a large-area proportional counter to perform a high-sensitivity survey for cosmic x-ray sources in the southern sky. The flight was successful and a total of 50 scans across the sky were obtained. Strong sources were observed in Centaurus and Scorpius, and weaker sources were observed in Taurus and in the Ara-Scorpius region. No further discrete sources were positively identified. (W.D.M.)

11120 CRUCIAL TEST FOR THE EXISTENCE OF A SOLAR QUADRUPOLE MOMENT. **Audretsch, J.; Dehnen, H.; Hoenl, H. (Univ., Freiburg i. B.). Astrophys. J., 150: L127-8(Dec. 1967).**

Recently Dicke and Goldenberg (1967) stated the opinion that one has to conclude a mass quadrupole moment for the Sun from the measurements of the solar oblateness. This would account for an excess motion of the perhelion of Mercury of +3.4" ± 0.6" per century. The question considered here is whether the solar quadrupole moment stated by Dicke and Goldenberg can be measured entirely independently of special assumptions concerning the physical structure of the Sun, because some of these assumptions may prove to be wrong (Cocke 1967). (W.D.M.)

11121 ON THE REMARKABLE SPECTROSCOPIC COMPLEXITIES OF CYG X-2. **Kraft, Robert P. (Univ. of California, Santa Cruz); Demoulin, Marie-Helene. Contract NsG 357. Astrophys. J., 150: L183-8(Dec. 1967).**

Since radial velocity observations of Cyg X-2 have been at best fragmentary, and since the question of the relationship of novae to the x-ray sources seems rather problematical, an attempt to obtain the radial velocity variation of Cyg X-2 is reported using the "continuous trailing" technique successfully employed earlier to detect the 81-min orbital period of Nova WZ Sge. The method consists simply of trailing the star once down a long slit so that the radial velocity unfolds with time rather than employing the conventional technique of smoothing the spectrum with several passes along the slit. Spectrograms were obtained at the prime focus of the 120 inch Lick reflector on the nights of October 5, 6, 7, and 8 U.T. (W.D.M.)

11122 OPTICAL VARIATION OF THE NUCLEI OF THREE COMPACT GALAXIES TOGETHER WITH NEW PHOTOMETRIC DATA FOR SEYFERT GALAXIES. **Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L177-81(Dec. 1967).**

Optical variations of the N-type galaxies 3C 109, 3C 390.3, and I Zw 1727 + 50 were found, which, together with 3C 371, bring the known number of optically variable nuclei to four. New photometry of radio and non-radio N-type galaxies continues to show a clear separation of quasi-stellar sources and compact galaxies in the U-B, B-V diagram. Variation of optical or radio intensity can no longer be used as an argument against the cosmological interpretation of redshifts because the optically variable galaxies, and the radio-variable Seyfert nuclei, NGC 1275 (Per A) and 3C 120, all follow the Hubble expansion law. (auth)

11123 A VARIABLE RADIO-QUIET COMPACT GALAXY I Zw 1727 + 50. **Oke, J. B.; Sargent, W. L. W.; Neugebauer, G.; Becklin, E. E. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L173-6(Dec. 1967).**

The continuous energy distributions of two Zwicky compact galaxies, I Zw 1727 + 50 and 3C 120, were measured. The first of these is variable both in brightness and color. In I Zw 1727 + 50 nonthermal radiation probably contributes to the visual radiation, but the flux does not continue to increase in the infrared. Reasons for this behavior are discussed. (auth)

11124 POSSIBLE RELATION BETWEEN AN OH SOURCE AND AN INFRARED OBJECT IN THE ORION NEBULA. **Raimond, Ernst; Eliasson, Baldur (California Inst. of Tech., Pasadena). Astrophys. J., 150: L171-2(Dec. 1967).**

Between January and July, 1967, observations of several of the brighter OH-emission sources were made using the two-element interferometer of the Owens Valley Radio Observatory and a 24-channel receiver. The band width of the channels was 1 kHz. The purpose of the observations was to obtain accurate positions and complete polarization data. Some results are reported concerning the OH source in the Orion Nebula. It turns out that in Orion the position of the OH-emission source is extremely close to that of the infrared point source discovered by Becklin and Neugebauer (1967). (W.D.M.)

11125 THE NATURE OF OH EMISSION SOURCES IN THE GALAXY. **Menon, T. K. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J., 150: L167-70(Dec. 1967).**

The mechanism of excitation of the anomalous emission of the 18-cm Λ-type multiplet OH has been the subject of a number of investigations during the last 2 years. In both (Litvak et al. (1966) and Shklovsky (1966)) models it appears that the individual velocity components of any member of the multiplet arise in separate sources. The present paper is concerned with the interpretation of the OH emission sources based on the kinematics of the sources. (W.D.M.)

11126 A NEW CLASS OF COMPACT H II REGIONS ASSOCIATED WITH OH EMISSION SOURCES. **Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Altenhoff, W.; Schraml, J.; Burke, B. F.; Reifenstein III, E. C.; Wilson, T. L. Contract DA-36-039-AMC-03200(1). Astrophys. J., 150: L157-66(Dec. 1967).**

Most of the OH emission sources have positions close to H II regions. The close correlation between the radial velocities derived from the observed Doppler shifts of the OH lines and the radio recombination lines show that this is not an observational selection effect but that OH emission clouds and H II regions are, in fact, closely associated in space. This was a result of the first H 109α recombination line survey (Mezger and Högland 1967). Subsequently, a program was started in which H II regions associated

with OH emission sources were investigated in detail. This program resulted in the detection of a new class of compact H II regions, on which this report is based. (W.D.M.)

11127 SPECTRAL DATA ON SCO X-1 IN THE ENERGY RANGE FROM 20 TO 100 keV. Lewin, W. H. G.; Clark, G. W.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Astrophys. J., 150: L153-5(Dec. 1967). (MIT-2098-386).

Substantial difference in the high-energy x-ray intensity of Sco X-1 is reported, based on a previous balloon observation of Peterson and Jacobson (1966) and an upper limit derived by the authors from a recent balloon flight. (W.D.M.)

11128 POLARIZATION OBSERVATIONS IN THE RADIO GALAXY 3C 371 AND THE X-RAY SOURCE CYG X-2. Visvanathan, N. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L149-51(Dec. 1967).

Prompted by Oke's (1967) discovery that the N-type radio galaxy 3C 371 varied over a magnitude during the last 2 years, polarization observations of 3C 371 were made at the Cassegrain focus of the 60 inch telescope. The observations of 3C 371 were made on October 3/4 and 4/5, 1967. An integration time of 10 sec was used for all measurements. The candidate star for the x-ray source, Cyg X-2, was also observed for polarization on three successive nights at the Cassegrain focus of the 100-inch telescope. The instrument and the method of observation were exactly the same as for 3C 371. An integration time of 8 sec was used for all measurements. (W.D.M.)

11129 UNSUCCESSFUL SEARCH FOR CIRCULAR POLARIZATION IN RADIO SOURCES AT 10.6-CM WAVELENGTH. Seielstad, G. A. (California Inst. of Tech., Pasadena). Astrophys. J., 150: L147-8(Dec. 1967).

Legg and Westfold (1967) have suggested that the synchrotron emission radiated by nonthermal radio sources may contain a circularly polarized component. Seielstad and Weiler (1967) have recently placed very low upper limits to the degree of circular polarization in the integrated 1418-Mc radiation from 57 radiogalaxies; in addition, they also investigated three supernova remnants at the same frequency but no quasars were included in their survey. Ginzburg and Ozernoi (1966) have discussed the possibility that the centimeter and decimeter wavelength radiation from such sources might be generated by a coherent plasma mechanism. If so, this radiation also might exhibit circular polarization. Consequently, the measurements made at a wavelength of 10.6 cm by Moltby and Seielstad (1966) were re-examined in an attempt to detect circular polarization. The results are presented for 14 nonthermal radio sources, including a supernova remnant, radio galaxies, and quasars. (W.D.M.)

11130 REDSHIFTS OF NINE RADIO GALAXIES. Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: L145-6(Dec. 1967).

Red shifts of nine radio galaxies were obtained as part of a continuing program of optical observation of objects in the 3C R catalog. The procedure for the present observations is the same as previously reported (Sandage 1966). All spectra were taken with the prime-focus spectrograph at the 200-inch telescope using a grating dispersion of 400 Å/mm. (W.D.M.)

11131 LEMAITRE UNIVERSES AND THE LOG N–LOG S RELATION. McVittie, G. C.; Stabell, R. (Univ. of Illinois, Urbana). Astrophys. J., 150: L141-4(Dec. 1967).

All models close to the asymptotic model of the second kind, A_2, in the model diagram have a log N–log S relation for constant luminosities and constant number densities with a portion of the curve in which the slope is more negative than $-3/2$. But it is not possible to explain the observed log N–log S relation simply by choosing a particular model like Kardashev's. It is seen that the slope is about –7.3 for a large range in flux density and volume (or equally important a large range in red shift). The slope becomes steeper than $-3/2$ only for $z > 1.2$. (W.D.M.)

11132 LEMAITRE'S UNIVERSE AND OBSERVATIONS. Kardashev, N. (Moscow State Univ.). Astrophys. J., 150: L135-9(Dec. 1967).

On the assumption that the expansion of the Universe is described by Lemaître's model, the observations of the distant quasi-stellar objects give a mean density $\rho_0 = 1.8 \times 10^{-30}$ g cm^{-3}, a "radius" $R_0 = 1.5 \times 10^{10}$ lt-yr, a cosmical constant $\Lambda = 4.3 \times 10^{-56}$ cm^{-2}, an acceleration parameter $q_0 = -1.3$, an age $t_0 = 67 \times 10^9$ years. The difference between this model and the static Einstein universe is very small ($\epsilon = 2 \times 10^{-5}$). Possibility of further observational confirmations is discussed. (auth)

11133 STIGMATIC BALLOON SPECTRA OF THE SOLAR Mg II DOUBLET. Lemaire, P.; Blamont, J. E. (CNRS, Verrieres-le-Buisson, France). Astrophys. J., 150: L129-34(Dec. 1967).

A balloon equipped with a biaxial solar pointing system (Burello, 1967) and a stigmatic spectrograph was launched on June 23, 1967, from Gap, France. The objective of the experiment was to measure the profile of the ionized magnesium lines (2795.523 and 2802.698 Å) (Purcell, Garrett, and Tousey, 1963). (auth)

11134 ISOTOPIC ABUNDANCE ANOMALIES IN THE SOLAR SYSTEM. Reynolds, John H. (Univ. of California, Berkeley). Contract AT(11-3)-34. Annu. Rev. Nucl. Sci., 17: 253-316(1967). (UCB-34P32-57).

Data on isotopic abundances in meteorites are reviewed. Evidence is presented for extraordinarily thorough isotopic mixing in the solar system. Cases in which abundance variations do occur are then discussed under the following headings: effects due to natural radioactivity, effects due to exposure of extraterrestrial material to cosmic rays, effects due to extinct radioactivity in the solar system, and effects for which no explanation has yet been found. The relation of the data to the origin and history of the meteorites is considered. (200 references) (A.G.W.)

11135 X RAYS FROM STARS AND NEBULAE. Friedman, Herbert. (Naval Research Lab., Washington, D. C.). Annu. Rev. Nucl. Sci., 17: 317-46(1967).

The discovery, distribution, and properties of cosmic x-ray sources are reviewed. Topics discussed include observational methods, spectra and intensities, surveys, x-ray luminosity of the galaxy, variability of x-ray sources, the Crab Nebula, Sco X-1, Cassiopeia A, and M87. 56 references. (W.D.M.)

11136 EAST LIMB PASSAGE OF AN ACTIVE SOLAR REGION, JULY 7–10, 1959. McKenna, Susan M. P. (Univ. of Michigan, Ann Arbor). Astrophys. J., 150: 1087-1104(Dec. 1967).

A comprehensive investigation is made of phenomena associated with the east limb passage of the center of activity HAO-59Q on July 7, 1959, and up to and including its production of a major proton flare on July 10. Detailed features of the optical observations are correlated with time-associated radio bursts and shortwave fadeouts. The optical, radio, and ionizing radiations identified as having been emitted from 59Q are considered to have been produced by particles accelerated to different speeds in the solar atmosphere. It is suggested that these particles were accelerated by disturbances of different magnitudes, channeled along the local magnetic flux tubes associated with the supergranular pattern. The force lines along which these particles were accelerated are envisaged to have extended to form an "onion dome" of magnetic loops high above the active region, thus providing trajectories along which material could be exchanged between different levels in the solar atmosphere. The various phenomena associated with flaring in 59Q appeared to require different particle energies to produce them so that these events may be considered to have acted as monitors of the magnitudes of the initial accelerating disturbances. The frequencies with which particles were accelerated to higher energies decreased markedly with the energy involved, and specific enduring parts of 59Q were repeatedly associated with the occurrence of especially energetic events. (auth)

11137 COMPARISON OF THE CONVECTIVE MODEL ATMOSPHERES OF EPSILON ERIDANI AND GMB 1830. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 150: 1161-5(Dec. 1967).

The onset of convection at small optical depth in a metal-deficient star is shown to arise as a result of the decrease in the adiabatic temperature gradient because of the dissociation of the hydrogen molecules and to a steep increase in the radiative temperature gradient brought about as a result of the increase in opacity. (auth)

11138 DIAMETER–LUMINOSITY RELATION FOR ELLIPTICAL AND SPIRAL GALAXIES. Heidmann, Jean (Observatoire de Paris-Meudon, Meudon, France). Compt. Rend., Ser. A and B, 265: 866-8(Oct. 16, 1967). (In French).

It is shown that there is a very significant relation between the grand axis A of a galaxy (up to a low fixed limited isophote) and its intrinsic luminosity L; this relation is of the form $L \propto A^q$, where q is close to 2 for elliptical galaxies and close to 3 for spiral galaxies. (tr-auth)

11139 NEW RESTRICTIONS ON MODELS FOR QUASI-STELLAR OBJECTS. Oster, L. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Nature (London), 217: 148-9(Jan. 13, 1968).

The inverse Compton effect has received attention as a possible source of the continuous radiation of quasars. In discussions on

this problem only the spontaneous component of the Compton effect was considered. There is also, however, a stimulated term which is a straightforward consequence of quantum mechanics. The purpose of the present communication is to show that the necessary inclusion of the stimulated processes makes an understanding of the radiation pattern of quasars extremely difficult in terms of currently proposed models. From the arguments put forward it is concluded that, whether the local or the cosmological hypothesis is adopted, there are two choices available: (a) The radiation field of quasars is caused by electrons supplied in situ, or not accelerated anywhere near the locus of the radiation field; the electrons at the low energy end of the spectrum are then decelerated "instantaneously", feeding the radiation field by means of stimulated Compton effect; or (b) production of the radiation field by a mechanism which does not involve relativistic electrons. (UK)

11140 NUCLEOSYNTHESIS DURING SILICON BURNING. **Bodansky, David (Univ. of Washington, Seattle. California Inst. of Tech., Pasadena); Clayton, Donald D.; Fowler, William A. Phys. Rev. Lett., 20: 161-4(Jan. 22, 1968).**

Silicon burning at temperatures in the neighborhood of 4×10^9°K was studied with the aid of a quasi-equilibrium model which describes the abundance of the nuclei in the interval $28 \leq A \leq 62$. It is found that, for a broad range of temperatures and densities, silicon burning leads to nuclear abundance distributions which match important features of the natural solar-system abundance distributions and that a large nuclear energy release accompanies silicon burning. (auth)

11141 SPIRAL STRUCTURE AND GALACTIC MAGNETIC FIELD. **Seymour, P. A. H. (Univ. of Manchester, Eng.). Nature (London), 217: 147-8(Jan. 13, 1968).**

There exist three different methods for determining the structure of the galactic magnetic field: (1) optical observations of interstellar polarisation; (2) Faraday rotation measures of extragalactic radio sources; (3) polarisation of the galactic radio emission. The present author carried out a spherical harmonic analysis of available data under these headings, and deduced the direction of the field in different regions of the Galaxy. The models of Hornby, and Bingham and Shakeshaft, are briefly discussed, and stated to be unable to explain the direction of the field in the plane of the Galaxy. It is stated that a toroidal field in the plane of the Galaxy can explain the Faraday rotation data, if it is assumed that the rotation is not confined to the local spiral arm. A simple radial component is not consistent with the data. A general toroidal field cannot be distorted by periodic disturbances, confined to the plane of the Galaxy, to give rise to the local spiral arm field, if the field lines are to remain connected and are not to cross each other. Hence it is supposed that there may also be systematic motions perpendicular to the galactic plane, or that the field lines in the spiral arms are not connected to the general galactic field. (UK)

11142 SOLAR RADIO BURSTS OF TYPE V INTERPRETED AS TYPE III's IN SUPERHEATED CORONAL STREAMERS. **Warwick, James W. (Univ. of Colorado, Boulder). Astrophys. J., 150: 1081-5(Dec. 1967).**

Fast-drift, Type-III, solar radio bursts are followed in a few per cent of cases by persistent bursts lasting ten times longer than the fast-drift burst itself. This enduring type of radio emission is called Type V by its discoverers. Type-V bursts are virtually identical with Type-III bursts, except in their durations. It is shown that Type-III bursts and, by extension, Type-V bursts are excited by electron streams in the outer corona. A Type-V burst, it appears, results from electron streams passing through a region heated several fold from the passage of the electron stream associated with the parent Type-III burst. (auth)

11143 ANALYSIS OF SPECTRAL-LINE PROFILES. II. AN APPLICATION TO THE SOLAR SODIUM D LINES. **Curtis, G. W. (High Altitude Observatory, Climax, Colo.); Jefferies, J. T. Astrophys. J., 150: 1061-80(Dec. 1967).**

On the basis of general principles set down in the first paper of this series, an analysis is made of Waddell's solar D-line observations. The results show a large measure of self-consistency and, among other conclusions, suggest that the temperature minimum in the solar atmosphere lies above $\tau_5 \sim 10^{-4}$, and that to a factor of order 2 the solar abundance of sodium is that given by LTE analyses. (auth)

11144 ANALYSIS OF SPECTRAL-LINE PROFILES. I. A GENERALIZED THEORY FOR THE SOLAR CASE. **Jefferies, J. T.; White, O. R. (Univ. of Hawaii, Honolulu). Astrophys. J., 150: 1051-9(Dec. 1967).**

Recent studies of spectral-line formation are shown to provide a basis for the analysis of profiles of multiplet lines in the "solar case," i.e., when limb-darkening data are available. The theoretical foundation is more general than that assuming local thermodynamic equilibrium, which is included as a special case. A detailed analytical procedure is given along with a discussion of its shortcomings and limitations. (auth)

11145 SOLAR DIFFERENTIAL ROTATION AND MERIDIONAL CURRENTS. **Cocke, W. J. (Goddard Space Flight Center, New York. Aerospace Corp., El Segundo, Calif.). Astrophys. J., 150: 1041-50(Dec. 1967).**

The solar differential rotation, and large-scale meridional currents are investigated with the axially symmetric, time-independent hydrodynamic equations of motion, including anisotropic convective viscosity forces. The ϕ component of the equations of motion is integrated to give a linear, ordinary differential equation determining the angular velocity distribution. The Reynolds number for the differential rotation in the convection zone is shown to be large, and an approximation based on this fact is used to solve the equations of motion to first order, under the assumption that the polar heating effects are negligible and that the convection zone is barytropic. A good fit to the observed differential rotation is obtained if the anisotropy parameter satisfies $s-1 \simeq 1/5$, and the differential rotation is then approximately independent of the magnitude of the dynamic convective viscosity η. The circulational velocities near the surface at high latitudes are $\sim (s-1)\rho^{-1}$ grad η. Reasonable agreement with observed values is shown. (auth)

11146 ADIABATIC PULSATIONS AND CONVECTIVE INSTABILITY OF GASEOUS MASSES. II. **Tassoul, Monique; Tassoul, Jean Louis (Univ. of Chicago). Astrophys. J., 150: 1031-40(Dec. 1967).**

The adiabatic pulsations of compressible Maclaurin spheroids are considered. The frequencies of oscillations which, in the absence of rotation, belong to the spherical harmonics $l = 1$ and $l = 3$ are found. It is shown that a uniform rotation entirely removes the degeneracy in the frequency spectrum; it also allows the presence of modes which vanish in the limiting cases of a sphere and an infinitely thin disk. When the adiabatic exponent γ is larger than a certain critical value $\gamma_c(4/3 < \gamma_c < 5/3)$, a sufficiently large angular velocity is able to remove the overstability associated with the modes which, in the absence of rotation, start as convective modes belonging to the spherical harmonics $l = 1$. (auth)

11147 SLOWLY ROTATING RELATIVISTIC STARS. I. EQUATIONS OF STRUCTURE. **Hartle, James B. (Univ. of California, Santa Barbara). Astrophys. J., 150: 1005-29(Dec. 1967).**

Equations are given for the calculation of the equilibrium configurations of slowly rotating stars in the framework of general relativity. The rotation is treated to second order in the angular velocity, but no other approximation is made. (auth)

11148 EFFECT OF ^{7}Be K CAPTURE ON THE SOLAR NEUTRINO FLUX. **Iben, Icko Jr.; Kalata, Kenneth; Schwartz, Judah (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 150: 1001-4(Dec. 1967).**

All other things being equal, bound-electron capture by the ^{7}Be nucleus near the solar center decreases the calculated rate of ^{8}B neutrino emission from the Sun. (auth)

11149 ENERGY LOSSES DUE TO NEUTRINO PROCESSES. **Beaudet, Gilles; Petrosian, Vahe; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 150: 979-99(Dec. 1967).**

The neutrino energy-loss rate due to the pair neutrino process, the photoneutrino process, and the plasma neutrino process, in a hot plasma, including the contribution from positrons present in the black-body radiation is considered. Some analytic expressions are derived for the pair neutrino rate and include the plasma effects on the photoneutrino rate. A discussion of the approximations involved in the derivation of the plasma neutrino rate is also given. An analytic formula is derived to reproduce the total energy rate of all three processes; it has a 5 to 15% precision in the temperature range of 10^8 to 10^{10} °K and is also fairly good from 10^7 to 10^{11} °K for all relevant densities. Finally, the total rate of the three processes combined is compared with some other processes with the recombination process and the Urca process being singled out. (auth)

11150 S-PROCESS NUCLEOSYNTHESIS IN THERMAL RELAXATION CYCLES. **Sanders, Robert H. (Princeton Univ., N. J.). Astrophys. J., 150: 971-7(Dec. 1967).**

Recent stellar models calculated by Schwarzchild and Härm indicate mixing of protons from the hydrogen envelope with the products of helium burning during thermal relaxation cycles. These models have been utilized here in the quantitative investigation of the nuclear consequences of such mixing, and it is found that conditions prevailing in these models are favorable for the production of free neutrons. The neutron flux and the number of iron nuclei exposed are shown to be of the order of magnitude necessary to produce the observed s-process abundances of an entire solar mass of Population I. (auth)

11151 HYDROGEN MIXING BY HELIUM-SHELL FLASHES. Schwarzschild, M.; Harm, R. (Princeton Univ., N. J.). Astrophys. J., 150: 961-70(Dec. 1967).

Numerical calculations were carried out which cover the first 4 million years of those evolution phases in which helium burning occurs in a shell in a star of 1 solar mass and of a Population-II composition. The thermal instability previously found to occur in these helium-shell-burning phases leads to relaxation oscillations—just as has already been shown by other authors for other types of stars. Thirteen consecutive relaxation cycles are covered by the present computations. In each cycle the main helium-shell flash causes a convective zone to stretch outward from the helium shell. In the initial relaxation cycles this convection zone does not reach the hydrogen-containing layers. However, cycle after cycle the main helium-shell flash increases in strength and, in consequence, causes a larger and larger convection zone. After about nine cycles the convection zone finally reaches the hydrogen-containing layers and from then on, for a short while in each cycle, hydrogen is mixed into the hot carbon-rich interior. This physical situation with its likely importance for nucleosynthesis had been searched for originally in connection with the helium-core flash, with, however, negative results; while now, in connection with the helium-shell flashes, the results seem to be encouragingly positive. (auth)

11152 STELLAR EVOLUTION WITH MASS LOSS. Hartwick, F. D. A. (Univ. of Toronto). Astrophys. J., 150: 953-9(Dec. 1967).

The object of this investigation was to determine some gross effects of mass loss on stellar evolution. A star of an initial mass of 15 $M_\odot$ is evolved from the main sequence, through core hydrogen burning, hydrogen exhaustion, shell hydrogen burning to past the onset of core helium burning. The star is continually losing mass at a rate ranging from 5.6×10^{-7} $M_\odot$/yr to 1.7×10^{-5} $M_\odot$/yr. The mass of the last computed model is 1.168 $M_\odot$. The early evolution is compared to that of a 15 $M_\odot$ star evolving at constant mass. It is concluded that extensive mass loss (1) broadens the main sequence near the turnoff point; (2) reduces the ages of clusters determined by fitting with conventional evolutionary tracks; and (3) that an upper limit exists to the amount of mass a star can lose if it is to become a red supergiant. (auth)

11153 REMARKS ON THE DISTANCE OF HYADES AND STELLAR MODELS. Wallerstein, George; Hodge, Paul (Univ. of Washington, Seattle). Astrophys. J., 150: 951-2(Dec. 1967).

It is shown that the inconsistencies discussed by Demarque between Hyades distance determinations and stellar models can be avoided with fairly good agreement of all important relevant data if the increase in the distance modulus is about +0.2, as previously derived by Faulkner, rather than +0.39, as suggested by Hodge and Wallerstein. (auth)

11154 DISTANCE MODULUS OF HYADES: DISTANCES IN THE UNIVERSE AND STELLAR INTERIORS. Demarque, Pierre (Univ. of Chicago). Astrophys. J., 150: 943-9(Dec. 1967).

It is shown that Hodge and Wallerstein's recent suggestion of a revision in the Hyades distance modulus does not remove the difficulties previously encountered by Iben and Bodenheimer in comparing the Hyades binaries with stellar interior models. The problem seems to lie with the individual parallaxes attributed to each binary system. It is also pointed out that a change in the Hyades distance modulus would not necessarily affect other distances in the Universe. (auth)

11155 OBSERVATIONS OF PROPER-MOTION STARS. III. Eggen, Olin J.; Greenstein, Jesse L. (Carnegie Institution of Washington, Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 150: 927-42(Dec. 1967).

Spectra, colors, and space motions are given for 31 additional white dwarfs. Figures illustrate, at low resolution, the appearance of normal DA stars, as well as the peculiar DB and red degenerate stars. The peculiar stars cover a wide range of UBV colors. Spectra are not uniquely determined by color, although DB stars occur in a narrowly limited range, and the lineless DC type is common among the redder stars. The reddest, and intrinsically faintest stars observed reach nearly to $M_V = +16$, and systematically are brighter and larger than expected, with deduced radii near 0.03 $R_\odot$. Stars with smaller radius than 0.01 $R_\odot$ are rare at all colors. The space motions of 132 stars of known luminosity are shown and demonstrate clearly the mixed nature of the sample; the tangential motions of 22% of the stars are less than 20 km/sec, but for 10% are larger than 100 km/sec. A peculiar concentration in velocity space exists for DB stars. Data are given on about 30 proper-motion stars that are not white dwarfs. A small group of these either have unacceptably high motions or are bluish stars of luminosity near +4 or +5. One, GD 210, = BPM 79017, may be variable. (auth)

11156 STATISTICAL-EQUILIBRIUM MODEL ATMOSPHERES FOR EARLY-TYPE STARS. II. FORMATION OF THE LYMAN CONTINUUM. Mihalas, Dimitri (Princeton Univ., N. J.). Astrophys. J., 150: 909-25(Dec. 1967).

Results are presented for model atmospheres which allow for deviations from LTE in the first ten bound states of hydrogen. Particular attention is given to the problem of solving the transfer equation in the Lyman continuum, using the approach of introducing the appropriate statistical equilibrium equation explicitly into the expression for the source function. The solution is carried out using Feautrier's method which treats the transfer equation directly in its differential equation form. Full variation with depth and frequency of all relevant parameters is allowed. The present solutions are not yet fully physically realistic since transfer in the bound–bound transitions is not included. From the present work, however, it appears that use of Feautrier's method will allow the treatment of the complete problem. (auth)

11157 MOLECULAR DISSOCIATIVE EQUILIBRIA IN CARBON STARS. Morris, Synnove (Bowling Green State Univ., Ohio); Wyller, Arne A. Astrophys. J., 150: 877-907(Dec. 1967).

The inference has been made that the low $^{12}C/^{13}C$ ratio found in a large class of carbon stars represents CNO-cycled equilibrium abundances mixed from the stellar interior to the surface. In order to explore further consequences of this assumption the H:C:N:O equilibrated abundances were calculated for shell-burning sources in red-giant models of 1.2, 4, and 10 $M_\odot$, which are taken to be representative masses for a variety of carbon stars. (auth)

11158 MAGNETIC, SPECTRUM, AND RADIAL VELOCITY VARIATIONS OF 73 DRACONIS. Preston, George W. (Univ. of California, Santa Cruz). Astrophys. J., 150: 871-6(Dec. 1967).

It is shown that 73 Draconis is an unusual spectrum variable, particularly with regard to its Mg, Mn, Y, and Ba variations, that its magnetic field is periodic, and that it is a single-line spectroscopic binary. The coincidence of magnetic minimum with light maximum is confirmed and the possibility of a secular variation in the magnetic range is noted. (auth)

11159 PHOTOMETRIC MONITORING OF SCO XR-1. Hiltner, W. A.; Mook, Delo E. (Univ. of Chicago). Astrophys. J., 150: 851-69(Dec. 1967).

Sco XR-1 was observed for approximately 89 hours during which time it was in a "flare" state about 12% of the time and always "flickering." The flares were up to 0.2 mag in height, minutes in duration, the rise and decay times similar, occurred when the object was bright, and most often appeared in multiples. There was no evidence for any period from 2 minutes to 1 hour. (auth)

11160 STRUCTURE OF THE BARNARD LOOP NEBULA AS DETERMINED FROM GEMINI 11 PHOTOGRAPHS. O'Dell, C. R. (Univ. of Chicago); York, Donald G.; Henize, Karl G. Astrophys. J., 150: 835-44(Dec. 1967).

Ultraviolet objective-prism photographs in the 2200 to 4900 Å wavelength region made from the Gemini 11 spacecraft have revealed an unexpected brightness of the Barnard Loop Nebula. Microphotometer tracings of the film have been reduced to absolute energy units by reference to stars of known flux. The form of the nebula differs significantly in the ultraviolet from that surface brightness distribution seen in the recombination line $H\alpha$. By comparison with optical wavelength measurements it is seen that in the optically brightest region the observed surface brightness is slightly greater than that predicted for pure atomic emission and that the discrepancy is usually even larger for other regions. It is hypothesized that the excess radiation is due to starlight scattered by interstellar grains in the nebula. Owing to its low optical depth, this radiation should clearly outline the structure of the nebula in both the ionized and un-ionized regions. It is shown that the surface brightness distribution requires a nonhomogeneous density distribution, with the total atomic density increasing outward. Such a density distribution may be the result of a dynamical radial force due to stellar radiation pressure acting on the grains mixed with the gas. (auth)

11161 TEMPERATURE DETERMINATIONS OF H II REGIONS. Peimbert, Manuel (Univ. of California, Berkeley). Astrophys. J., 150: 825-34(Dec. 1967).

The effect that temperature fluctuations inside H II regions have on the value of the temperature determined from observations is studied. New photoelectric observations of M8, M17, and three regions of the Orion Nebula are discussed; the intensity ratios of auroral to nebular forbidden lines of O^+, O^{2+}, and N^+ were measured in all five regions, whereas the intensity ratio of

Balmer continuum to Balmer line was obtained for the last three. The temperatures obtained by means of the forbidden lines are found to be larger than those determined from the Balmer continuum and the published radio astronomical values. It is found that at least part of this difference can be accounted for by temperature fluctuations inside H II regions. (auth)

11162 GALACTIC H II REGIONS. III. THE NATURE OF THE RADIO SOURCE W49. **Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.); Schraml, J.; Terzian, Yervant. Astrophys. J., 150: 807-23(Dec. 1967).**

The galactic radio source W49 is one of two associations of thermal sources, nonthermal sources, and OH-emission clouds found in an earlier survey of the free-free continuum and H109α recombination line radiation of twenty galactic radio sources. In this paper the nature of W49 is investigated using the results of high angular resolution continuum observations in the frequency range 195 MHz $\leq \nu \leq$ 154 GHz. W49 consists of a thermal component A (G43.2 + 0.0) and a nonthermal component B (G43.3−0.2). Both components are nearly at the same distance, 14.1 kpc, from the Sun and at a distance of about 10 kpc from the galactic center. The projected distance between the centers of components A and B is 12'.5 or 51 pc. If the nonthermal component B is a supernova remnant, it must be a considerably older and originally a much more powerful supernova remnant than Cassiopeia A. Both the analysis of the spectrum and the high-angular-resolution observations of the brightness temperature distribution of the radio continuum of the thermal component A suggest that it consists of A2, of small size (2R < 1 pc) and high density ($N_0 > 10^4$ cm^{-3}) imbedded in a component, A1, of lower electron density ($N_0 = 234$ cm^{-3}) and larger diameter (2R = 14.4 pc). It needs from six to eleven O5 stars to ionize component A2. These high-density condensations may be the ionized shells (cocoons) of recently formed stars, whose existence has been predicted by Davidson and Harwit. Nonthermal emission of the 18-cm OH lines close to W49 comes from two emission centers which are closely associated in space with the thermal component A. The OH-emission centers seem to coincide with the position of the thermal high-density condensations A2; this indicates a close correlation between star formation and nonthermal OH emission. The total thermal component A is surrounded by a shell of neutral hydrogen, for which an upper limit of 3.2×10^5 solar masses of H I is obtained. Shell and H II regions together form a gravitationally stable system, which could be the early stage of an O- and B-star association. The nonthermal component B, probably an old supernova remnant, is located at the outer edge of the shell of neutral hydrogen. (auth)

11163 GRAVITATIONAL EXPERIMENTS WITH A CYLINDRICAL GALAXY. **Hockney, R. W. (Stanford Univ., Calif.). Astrophys. J., 150: 797-806(Dec. 1967).**

A collisionless computer model is used to perform gravitational experiments with a two-dimensional galaxy. The motion of 2000 rods of mass is computed step-wise in time as they move according to Newton's laws of motion in their mutual gravitational field. The results are displayed as a movie and show the types of galactic structure that can arise from purely gravitational effects. A galaxy with insufficient rotation to balance gravitational attraction is seen to collapse and form filamentary condensations, then to change through structures similar to the "spirals" and "barred spirals," and finally to settle down to a cylindrical form reminiscent of an "elliptical" galaxy. (auth)

11164 SELF-CONSISTENT MODELS OF DISK GALAXIES. **Ng, E. W. (Columbia Univ., New York). Astrophys. J., 150: 787-96(Dec. 1967).**

Time-independent, axisymmetric, self-consistent models were constructed for encounter-free infinitesimally thin stellar systems. A special form of the stellar distribution function was assumed, viz.,

$$f(E,J) = \begin{cases} Ae^{-\alpha E+\beta J} & \text{for } E < E_0 \\ 0 & \text{for } E > E_0, \end{cases}$$

where E and J are the energy and angular momentum integrals and A, α, β, and E_0 are parameters. This function is substituted in the right-hand side of Poisson's equation, which then becomes a nonlinear equation for the gravitational potential. An iterative procedure for the solution of this equation was developed, and numerical results were obtained for different values of the relevant parameters. (auth)

11165 PECULIAR GALAXY THAT MAY BE AT A YOUNG EVOLUTIONARY STAGE. **Burbidge, E. Margaret; Burbidge, G. R.; Shelton, J. W. (Univ. of California, San Diego). Astrophys. J., 150: 783-6(Dec. 1967).**

The redshift and velocity field were measured in an unusual "integral sign" galaxy. The object has the very large over-all dimension of 45 kpc, has no nuclear concentration of stars, and contains much ionized gas. It is not in interaction with any other galaxy. A velocity gradient was measured; if due to rotation, it yields an approximate mass of 5×10^{10} cosec^2 ξ M⊙ (ξ being the unknown angle of inclination). The evolutionary stage of the object is discussed. (auth)

11166 NEW LIMITS ON THE DIAMETERS OF RADIO SOURCES. **Cohen, M. H. (Univ. of California, San Diego); Gundermann, E. J.; Harris, D. E. Astrophys. J., 150: 767-82(Dec. 1967).**

The interplanetary scintillations of seventy radio sources were studied in detail. The width of the spectrum of scintillation fluctuations gives a measure of source diameter. Upper limits from 0".5 to 0".04 are obtained. It is shown that most sources are not disks but probably consist of small-scale and large-scale components. The strength of scintillations is a measure of the strength of the small-scale component. A table is also given of sixty-eight sources which do not show scintillation. There is excellent agreement between diameters (or limits thereto) deduced from scintillation observations and those obtained from interferometer observations. Scintillating and nonscintillating galaxies have similar distributions of radio-frequency spectral index, but scintillating and nonscintillating quasars have different distributions. The former contain a predominance of curved and flat spectra; the latter are clustered between α = 0.8 and 1.1. (auth)

11167 LAGGING-CORE MODEL FOR QUASI-STELLAR SOURCES. **Ne'eman, Yuval (Tel-Aviv Univ., Israel. Southwest Center for Advanced Studies, Dallas); Tauber, Gerald. Astrophys. J., 150: 755-66(Dec. 1967).**

The model in which quasi-stellar sources are assumed to consist of lagging massive cores due to inhomogeneities of the original cosmological expansion is investigated. It is found that in the approximation of spatial isotropy the resulting expansion is too fast to account for the observed data, except in the case when a cosmological constant is introduced. However, if the expansion is followed by oscillations of the core, it is possible to account for the observed pulsations. For this purpose a phenomenological equation of state is constructed. It is possible to choose the constants so that these oscillations do not penetrate the Schwarzchild sphere. These solutions can then be joined to a nonisotropic exterior solution imbedded in a Friedmann universe. To obtain complete fitting, solutions with nonisotropic pressure should be used. (auth)

11168 ON THE PROPAGATION OF LIGHT IN INHOMOGENEOUS COSMOLOGIES. I. MEAN EFFECTS. **Gunn, James E. (California Inst. of Tech., Pasadena). Contract NAS 7-100. Astrophys. J., 150: 737-53(Dec. 1967).**

The statistical effects of local inhomogeneities on the propagation of light are investigated, and deviations (including rms fluctuations) from the idealized behavior in homogeneous universes are investigated by a perturbation-theoretic approach. The effect discussed by Feynman and recently by Bertotti of the density of the intergalactic medium being systematically lower than the mean mass density is examined, and expressions for the effect valid at all red shifts are derived. (auth)

11169 DIFFUSE COSMIC X-RAY BACKGROUND BETWEEN 4 AND 40 keV. **Seward, F.; Chodil, G.; Mark, Hans; Swift, C.; Toor, A. (Univ. of California, Livermore). Astrophys. J., 150: 845-50(Dec. 1967).**

Diffuse x-ray background fluxes have been observed in many of the rocket flights made to study discrete x-ray sources. The x-ray background spectrum observed in two recent (September 20 and September 22, 1966) flights from Johnston Island is presented. Observations were made of backgrounds perpendicular to and in the galactic plane. The x-ray flux was found to be roughly isotropic. It follows a power law spectrum having $N(E) \propto E^{-1.6}$. The total radiated energy observed between 4 and 40 keV is 9×10^{-8} ergs cm^{-2} sec^{-1} sterad^{-1}. (auth)

11170 THE JODRELL BANK MARK III RADIO TELESCOPE. **Palmer, H. P.; Rowson, B. (Univ. of Manchester, Eng.). Nature (London), 217: 21-2(Jan. 6, 1968).**

A radio telescope which can be dismantled and reassembled at a new site within 6 months is being used for interferometer measurements in conjunction with fixed instruments at Jodrell Bank. A description of this telescope is given. (auth)

11171 THE RADIO SPECTRA OF SOURCES IN THE FOURTH CAMBRIDGE CATALOGUE. II. **Williams, P. J. S.; Stewart, P. Mon. Notic. Roy. Astron. Soc., 135: 319-28(1967).**

Using observations at 38, 178, 610.5 and 1417 Mc the radio spectra of sources in the declination range 40 to 44° of the 4C catalogue were determined. Comparing the spectral indices of sources in lists compiled at 38, 178, and 610.5 Mc, it is seen how the mean spectral index of a list of sources selected ac-

cording to flux density at a given frequency is a function of that frequency. (auth) (UK)

11172 THE CHEMICAL COMPOSITION OF THE BINARY PECULIAR A STAR HR 4072. Guthrie, B. N. G. Mon. Notic. Roy. Astron. Soc., 137: 235-6(1967).

The peculiar A star HR 4072 = HD 89822 was found to be a double-line spectroscopic binary on spectra at a dispersion of 5.6 Å/mm taken with the Edinburgh 36-in. telescope on May 18, 1966, and May 23, 1966. Equivalent widths of 76 unblended lines in the primary, and 24 lines in the secondary, were measured in the wavelength range 4070 to 4510 Å. The chemical composition of the atmosphere of the primary was determined by a differential curve-of-growth analysis with α Lyr as the comparison star. Groups of lines of similar mean excitation and ionization potentials and wavelengths were used, so that the results would not be seriously affected by possible abnormalities in the structure of the primary. Si, Mn, Sr, and Y are overabundant by factors of about 20, 4, 100, and 200, respectively, while Sc is deficient by a factor of at least 5; the abundances of Mg, Ti, Cr, and Fe are about normal. The chemical composition of the secondary was studied by comparing it with the primary. The relative abundances of Ti, Cr, Fe, Sr, and Y in the secondary are roughly similar to those in the primary, but the overabundance of Sr and Y relative to Ti, Cr, and Fe may be slightly smaller in the secondary. The strengths of the MgII 4481 line in the primary and secondary components indicate that the relative luminosities L_1 and L_2 of the primary and secondary components are approximately given by $L_1/L_2 = 4.76$. Reference is made to other double-line peculiar A binaries (41 Eri, HD 98088, and 112 Her) discussed by other authors. Since the lines in HR 4072 are very sharp, it is suggested that further investigations at higher resolution might be worth while, especially in order to determine whether the secondary has a magnetic field with variations related to those of the primary. (auth) (UK)

11173 AN INTERPRETATION OF THE TOTAL INTENSITIES OF THE LYMAN α AND β LINES OF HYDROGEN EMITTED BY THE SUN. Hearn, A. G. Mon. Notic. Roy. Astron. Soc., 135: 305-18(1967).

Measurements of the absolute intensities of the Lyman α and β lines of hydrogen emitted by the Sun are used in an interpretation of the mean electron temperature and density of the layers emitting these lines. Calculations of the line intensities emitted by a finite, uniform plane parallel atmosphere were used, where the coupled equations of statistical equilibrium and radiative transfer in the lines were solved explicitly for the first nineteen levels, including the effect of the radiation from the photosphere. In order to obtain a unique interpretation for the electron temperature a third measurement is required, and the calculations show that the geometrical thickness of the layers emitting the two lines is very sensitive to the electron temperature. No measurement of this thickness has been made, but an upper limit is obtained which corresponds to a maximum electron temperature of 30,000°K. There is a lower limit to the electron temperature of a little under 16,000°K. The limits of electron density corresponding to these temperatures are 10^9 to 10^{11} cm^{-3}. (auth) (UK)

11174 MINIMUM MASS OF MAIN SEQUENCE STARS. Gabriel, M. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg., 53: 459-68(1967). (In French).

The maximum central temperature of low-mass stars and the minimum mass of main-sequence stars are calculated as functions of the chemical composition. The results are in good agreement with those of Kumar but diverge slightly from those of Hayashi. (auth)

11175 A PHENOMENOLOGICAL MODEL FOR DISPARITIONS BRUSQUES FOLLOWED BY FLARELIKE CHROMOSPHERIC BRIGHTENINGS. II. OBSERVATIONS IN ACTIVE REGIONS. Hyder, Charles L. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Solar Phys., 2: 267-84(Nov. 1967).

The study of the disparitions brusques to flarelike brightening process in Paper I led to many specific characteristics that appear to agree with the observations. Therefore, the consequences of the model for active-region flares as well is tested. As in Paper I, agreement is found between the predictions of the model and the available observational data. The class-III flare of August 28, 1966, is discussed in detail. The possibility that the gravitational infall–chromospheric impact mechanism may be the source of energy for other chromospheric phenomena, such as the bright network seen in Ca II K_2, plages, "normal" flares, etc., is considered. The available data certainly indicate that the infall–impact mechanism should be studied further, but no firm conclusions as to its overall importance can be drawn at the present time. The prominence destabilization mechanism and its significance to flare predictability is explored in a somewhat speculative manner. Changing multipole fields appear to yield the necessary space and time behaviors to fit the observed behavior of eruptive prominences. As in Paper I, the major conclusion is that the model looks good, but specific and detailed observations to test the model are needed. (auth)

11176 DIFFUSION OF SPICULES IN THE SOLAR CORONA. Mouradian, Z. (Observatoire de Meudon, France). Solar Phys., 2: 258-66(Nov. 1967). (In French).

The width of spicules as a function of time was measured on films. A broadening phenomenon, due to the diffusion of spicular material into the corona, was established very clearly. An empirical model of spicules is given and compared with that of the surrounding corona. The mass balance between spicules and flocculi is computed. (tr-auth)

11177 EVERSHED EFFECT AS A WAVE PHENOMENON. Maltby, P.; Eriksen, G. (Univ. of Oslo). Solar Phys., 2: 249-57(Nov. 1967).

It is suggested that longitudinal compression waves are propagating parallel to the solar surface from the umbra towards the photosphere. It is shown that the line-absorption coefficient is asymmetrical, when integrated over a wavelength of the compression wave. The effect of the waves on the line profile is discussed, and it is shown that asymmetrical line profiles of the type observed in sunspot penumbrae will be produced. With the Evershed effect interpreted as an acoustical wave phenomenon the propagation (of the waves) may also be perpendicular to the magnetic lines of force, whereas material motion is likely to be restricted to the direction along the lines of force. (auth)

11178 INTERPLANETARY SECTOR STRUCTURE, 1962–1966. Ness, Norman F. (Goddard Space Flight Center, Greenbelt, Md.); Wilcox, John M. Solar Phys., 2: 351-9(Nov. 1967).

Some properties of the interplanetary magnetic field observed by IMP-3 in the latter half of 1965 are discussed with relation to previous satellite observations of the interplanetary field. The sector property remains a prominent feature of the observations, with the average field direction at the Archimedes spiral angle. The sector pattern has a 27-day recurrence period from 1962 to 1964, and during the year 1964 the pattern appears to be quasi-stable. In 1965 the recurrence period is about 28 days, and the evolution of the pattern is more rapid, with new sectors appearing and expanding. (auth)

11179 NOTE ON SOLAR HARD X-RAY BURSTS. de Jager, C. (Utrecht Univ. Space Research Lab., Utrecht). Solar Phys., 2: 347-50(Nov. 1967).

Observationally solar x-ray bursts fall into three different categories: soft bursts (E < 10 keV), deka-keV bursts (10 to 150 keV), and very hard bursts or deci-MeV bursts (200 to 1000 keV). The first kind is quasi-thermal, the last kind is nonthermal. The real existence of the third kind of burst looks probable but has not yet been proved by direct observations. The difference between deci-MeV and deka-keV bursts may mainly be a matter of geometry of the emitting plasma. (auth)

11180 HARD SOLAR X-RAY BURST OF SEPTEMBER 18, 1963. de Jager, C. (Utrecht Univ. Space Research Lab., Utrecht). Solar Phys., 2: 327-46(Nov. 1967).

A hard solar x-ray burst was observed on September 18, 1963, 13:56 UT, at balloon altitude. It lasted a few minutes; a steep increase was followed by an exponential decay. During its declining phase a weak radio burst was observed on 3 and 10 cm, not on longer wavelengths. Maximum radio intensity occurred two minutes after that of the x-ray burst. The x-ray and radio bursts ended almost simultaneously. Optically a small shortlived (≤some minutes) flare point occurred simultaneously with the x-ray burst in a magnetically interesting part of the active region of September 1963. The x-burst photons seem to have had an energy of about 0.5 MeV. The burst was therefore of a fairly rare type, since very few other bursts with similar photon energies have been detected up to now. It is suggested that a mass of gas, magnetically confined to a volume of about 5.10^{25} cm^3 in the low corona, containing about 3.10^{38} electrons was accelerated to energies of about 0.5 MeV. The gas gradually expanded, partly also to higher levels. The gyrosynchrotron radiation, emitted by the plasma became observable after about two minutes. At the lower radio frequencies the radiation was absorbed by overlying undisturbed coronal matter. Quantitative computations justify this model. A detailed summary of the events, and some numerical data are given. (auth)

11181 HOMOLOGY OF SOLAR FLARE-ASSOCIATED RADIO EVENTS. Fokker, A. D. (Utrecht Univ.). Solar Phys., 2: 316-26(Nov. 1967).

The concept of homology, introduced for optical flares, can be extended to flare-associated radio events. Successive flares within the same center of activity sometimes produce radio events that

are remarkably similar. The similarity amounts to the fact that they extend over about the same range(s) in frequency, producing at each frequency responses of comparable intensity and duration. On some occasions the intensity curves at individual frequencies show even detailed resemblance. The occurrence of homologous radio events is commonly restricted to periods of less than 48 hours. Without being homologous, radio events that occur in the same center of activity may present a common characteristic that is typical for that center. Two such characteristics are (1) the production of radio responses at centimetric, decimetric, and metric frequencies, and (2) the impulsiveness of microwave outbursts. The distribution of time intervals during which such bursts occur is compared with the same distribution for homologous events. (auth)

11182 SOLAR CORONA ABOVE ACTIVE REGIONS: A COMPARISON OF EXTREME ULTRAVIOLET LINE EMISSION WITH RADIO EMISSION. Neupert, Werner M. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 2: 294-315(Nov. 1967).

The observation of extreme ultraviolet (EUV) emission lines of Fe IX through Fe XVI made by Orbiting Solar Observatory-1 is discussed and applied to a study of the solar corona above active regions. Ultraviolet and radio emission are determined and compared for several levels of activity classified according to the type of sunspot group associated with the active region. Both radio emission and line radiation from Fe XVI, the highest stage of ionization of Fe observed, are observed to increase rapidly with the onset of activity and are most intense over an E-spot group early in the lifetime of the active region. As activity diminishes, radiation from Fe XV and Fe XVI becomes relatively more prominent. The observations imply that the coronal temperature reaches a maximum during the period of highest activity, as indicated by sunspot-group complexity and the occurrence of chromospheric flares. A maximum coronal electron temperature of 4.0×10^{6}°K is estimated when taking into account the mechanism of dielectronic recombination. Concurrently, the average coronal electron density increases by a factor of 10 to 12. Both electron temperature and density decrease as activity subsides. The coronal temperature above the remaining Ca II plage is estimated to be 2.5 to 3.0×10^{6}°K after flare activity has ceased and sunspots have disappeared. (auth)

11183 ABSOLUTE INTENSITIES IN THE SOLAR X-RAY SPECTRUM NEAR MINIMUM ACTIVITY. Van Gils, J. N.; De Graaff, W. (Space Research Lab., Utrecht). Solar Phys., 2: 290-3(Nov. 1967).

Rocket measurements of absolute intensities in the solar x-ray spectrum on November 4, 1964, around 16:35 UT yield the following results: 1.8×10^{-2} erg cm^{-2} sec^{-1} (wavelength band 44 to 60 Å); and 1.5×10^{-3} erg cm^{-2} sec^{-1} (wavelength band 8 to 15 Å). These values were obtained under nearly quiet minimum conditions of the Sun. (auth)

11184 SIMULATION OF SPACE PLASMA BY LASER-PRODUCED PLASMA. Tsuchimori, Noriyuki; Yamanaka, Tatsuhiko; Yamanaka, Chiyoe (Osaka Univ.). Jap. J. Appl. Phys., 7: 84(1968).

Experiments on laser produced plasma were performed to simulate a mechanism of acceleration of particles of the solar flare. The method and results are briefly described. (M.O.W.)

11185 DENSITY DISTRIBUTION OF THE RR LYRAE-TYPE VARIABLE STARS. White, Raymond Edwin Jr. Urbana, Ill., Univ. of Illinois, 1967. 152p.

Thesis.

For each of two different values of M_B (RR Lyr), +0.5 and +0.9, a new galaxy-wide, smooth density distribution is found for the field RR Lyrae-type variable stars. Elliptical isodensity contours are generated for the field variables by a different approach to the problems of accurately combining the volume elements in the chosen variable star fields. The thirty-six published variable star fields used by Perek (1950), and later by Plaut and Soudan (1963), are re-inspected for their RR lyrae variables. Two new star fields are added from the literature. One combined field used by Perek is separated into its two separate components. In the resultant 39 systematically searched star fields, a total of 1515 field RR Lyrae variables are recovered for completeness analysis. The values of the local RR Lyrae star density, for the respective values of +0.5 and +0.9 for M_B (RR Lyr), are determined to be 41.0 and 71.6 stars/kpc^3 by graphically interpolating the isodensity contours. The term "local" refers to values at the Sun, that is: z = 0 and R = 10 kpc. The density profile of the contours in the direction of the North Galactic Pole ($b^{II} = +90°$) from the Sun is compared to other, fainter, observations (Kinman, Wirtanen, and Janes 1966). This shows that the smoothing techniques that have been used are accurate. (Disser. Abstr.)

11186 HIGH-TEMPERATURE EQUILIBRIA AND CONDENSATION AND SOLAR WIND INTERACTION WITH SOLIDS. Lord III, Harry Chester. San Diego, Calif., Univ. of California, 1967. 159p.

Thesis.

Part I. An expanded presentation is given of the work by Lord (1965). This is a study of the molecular equilibria present in a gas cloud with cosmic elemental abundances, temperatures of 2000 or 1700°K, and total pressures of approximately 1 and 5×10^{-4} atm. with special consideration of the formation of a condensed phase. From some 150 species considered, Al_2O_3, HfO_2, W, ZrO_2, and $MgAl_2O_4$ are found to be condensed at 2000°K at a total pressure of 1 atm. Decreasing the temperature or increasing the pressure condenses more species, which in general are of complex structure. It is shown that in the atmospheres of cool stars polyatomic molecules and possibly condensed species play an important role. The calculated equilibria should be useful for spectral studies, and the order and type of condensates should prove helpful in cosmochemical problems. Using the technique of flash heating to produce the vapor phase, condensation in simple systems is studied. Vaporization of iron has given a supersaturated vapor which condensed as small spherules (≤1000 Å diameter). One wants to study the condensation from the O–Si–Mg–Fe–Al system and in particular look for those species which are predicted in the above work to be the primary condensates. However, principally because of the spectral distribution of the lamp, these refractory materials are not vaporized. Melting is observed but no new phases are detected. Part II. The solar wind is thought to be a principal source of primordial rare gases in meteorites and may also be effective in the identification of cosmic dust. To simulate the effects of the solar wind, olivine was irradiated with 2-keV protons, and olivine, dunite, enstatite, and fayalite were irradiated with 1.8-keV He ions. Both the hydrogen and helium are quantitatively retained at the lowest integrated fluxes used ($\sim 5 \times 10^{16}$ ions/cm^2). Decreased retention with increasing integrated flux (saturation effects) is observed. X-ray diffraction analysis, electron-probe microanalysis, microscopic analysis, and studies of the characteristic x-rays produced by low-energy protons, have been performed on the bombarded surfaces. Only the last technique detected elemental composition changes, and most likely these are only a result of the irradiation instrumentation. Samples of Pesyanoe, Norton County, and Plainview meteorites and a biotite sample have been analyzed for H_2 and He. Gas release curves and diffusion constants are derived and compared with the experimental studies described above. (Disser. Abstr.)

11187 COMPUTER MODEL FOR PLANETARY NEBULAE. Turoff, Murray. Waltham, Mass., Brandeis Univ., 1965. 121p.

Thesis.

The planetary nebulae problem is treated by constructing a computer model that will produce a consistent solution for such variables, within the nebular shell, as the radiation field, electron temperature, ionization densities, and expansion velocities of the elements. The nebula is characterized by such parameters as the average density of particle, average expansion velocity, size, relative abundances, and temperature of the central star. An equal measure of treatment is provided the three physical problem areas associated with planetary nebulae: radiative transfer, gas dynamics, and gas structure. The problem is treated in as much detail and accuracy as is consistent with both available computers and inherent observational inaccuracies. (Disser. Abstr.)

11188 VENUSIAN AND INTERSTELLAR SODIUM. Hobbs, Lewis Mankin. Madison, Wis., Univ. of Wisconsin, 1966. 94p.

Thesis.

This study consists of observations of the sodium resonance lines at 5890 Å and 5896 Å in the spectra of Venus and the star α Cygni, at resolving powers of 5×10^5 and higher. A three-etalon PEPSIOS spectrometer was used in all cases. The first set of observations was made at the coudé focus of the 120-inch telescope at Lick Observatory in the autumn of 1964, followed by a second series at the 60-inch solar telescope at Kitt Peak National Observatory in June 1965. For Venus the object of the study is to determine the abundance of atomic sodium above the cloud layer in the Venus atmosphere. This is achieved by comparing the profiles of the Fraunhofer D lines in the spectrum of Venus with those in the solar spectrum, particularly at those wavelengths where resonance absorption or scattering due to sodium in the Venus atmosphere is expected to occur. In over fifty scans of the Venus spectrum, no evidence is seen for any spectral feature due to sodium, at the calculated wavelengths. An upper limit to the equivalent width of such a feature is thus deduced to be (2.9 ± 0.3) mK. On the basis of a simple model for the Venus atmosphere, this requires the upper limit for the abundance of atomic sodium above the cloud layer to be $(5.0 \pm 0.5) \times 10^9$ cm^{-2}. The methods by which corrections to the observed spectrum are made for the effects of the variable trans-

mittance of the Earth's atmosphere and of light contributed by the day sky are discussed. For α Cygni the object of the study is to resolve all spectral details present in the sodium D_2 interstellar lines appearing in the spectrum. Scans of the spectrum reveal a doubling of two of the five components already known to be present. The two newly resolved pairs each have a spacing that can be taken to be 57 mK, in agreement with what is required for the s-resolved hyperfine-structure components of sodium. The strengths of the line pairs should be in the ratio 5:3, if the ground levels are equally populated and the lines are unsaturated. The lines appear to have roughly equal strengths and to be at least partially saturated. Pending further study, the doubling of the two components is attributed to hyperfine structure. (Disser. Abstr.)

11189 MEASUREMENTS OF THE MAGNETIC FIELDS IN QUIESCENT SOLAR PROMINENCES. Rust, David Maurice. Boulder, Colo., Univ. of Colorado, 1966. 193p.

Thesis.

The magnetic field observations described were made with the new solar magnetograph of the High Altitude Observatory. This instrument was designed especially for measurements of the Zeeman splitting in the H_α emission line of solar prominences. The description of the magnetograph as it is used with the coronagraph at Climax, Colorado includes details of the methods employed in calibration and in operation. The intensity of the line-of-sight component of the magnetic field has been inferred from measurements in nearly 100 prominences, most of them quiescent. The measurements were made of about 20" arc resolution. The estimated error in most cases is ±2 gauss. The observations were obtained during the winter of 1964–65 and in the fall of 1965. To provide a starting point for analysis of the data, maps of the longitudinal photospheric fields from the Mount Wilson Observatory were assumed to give the distribution of the sources of the magnetic fields in the solar atmosphere. From these maps the fields were calculated with the potential theory and the results compared with the observed fields. The principal results are given. It is suggested that stable fields suitable for prominence support occur naturally in the context of Leighton's theory of the random transport of fields across the surface of the sun. Apparently, the material motions in supergranules sweep tiny ropes with intense fields across the boundaries between regions of opposite polarity. The lines of force in the solar atmosphere above the region where this takes place have depressions at which material can be supported. It is suggested that the material collects in such depressions to give a prominence a bush-like appearance and that a long prominence is just a row of such bushes (hedgerow). The calculated field configuration of the model compares well with that inferred from high resolution photographs of prominences and from studies of the trajectories of bright, rapidly-moving knots near stable features. (Disser. Abstr.)

11190 RELATIVITY THEORY AND ASTROPHYSICS. 3. STELLAR STRUCTURE. Ehlers, Jurgen (ed.). Lectures in Applied Mathematics. Volume 10. Providence, American Mathematical Society, 1967. 140p. $6.70.

Lectures are presented on stellar structure leading up to white dwarfs and neutron stars, the post-Newtonian equations of hydrodynamics in general relativity, the post-Newtonian effects on the equilibrium of the Maclaurin spheroids, the stability of gaseous masses in the post-Newtonian approximation, hydrodynamic calculations of general relativistic collapse, and observer time as a coordinate in relativistic hydrodynamics. (W.D.M.)

11191 RELATIVITY THEORY AND ASTROPHYSICS. 2. GALACTIC STRUCTURE. Ehlers, Jurgen (ed.). Lectures in Applied Mathematics. Volume 9. Providence, American Mathematical Society, 1967. 226p. $8.10.

Lectures are presented on structure and dynamics of galaxies, stellar dynamical theory of normal spirals, applications of the third integral in the Galaxy, dynamics of star clusters, cooperative phenomena in stellar dynamics, fragmentation, radiogalaxies, and cosmic radiation. (W.D.M.)

11192 RELATIVITY THEORY AND ASTROPHYSICS. 1. RELATIVITY AND COSMOLOGY. Ehlers, Jurgen (ed.). Lectures in Applied Mathematics. Volume 8. Providence, American Mathematical Society, 1967. 303p. $9.40.

Lectures are presented on general relativity theory, comparison of theory and observation in general relativity, experimental tests of general relativity by radar, gravitational waves, measurements of space–time curvature and search for gravitational radiation, conserved quantities and conformal structure in general relativity, Taub-NUT space as a counterexample to almost anything, relativistic hydrodynamics, gravitational collapse, dragging of inertial frames by rotating masses, quasi-stellar objects, cosmology, unified approach to cosmology, Jean's formula for gravitational instability, and microwave radiation from the big bang. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 11501, 11509, 11537, 11538, 11543, 11544, 11547, 11697, 11762, 11805, 11968, and 11987.

11193 (CALT–532–20) DETERMINATION OF ELECTRONIC ENERGY LEVELS OF MOLECULES BY 90° LOW ENERGY ELECTRON SCATTERING. Wei, Pax Samuel Pin (California Inst. of Tech., Pasadena). Oct. 10, 1967. 282p. Dep. CFSTI.

Thesis.

A review of the theory of electron scattering indicates that low incident beam energies and large scattering angles are the favorable conditions for the observation of optically forbidden transitions in atoms and molecules. An apparatus capable of yielding electron impact spectra at 90° with incident electron beam energies between 30 and 50 electron volts is described. The resolution of the instrument is about 1 electron volt. Impact spectra of thirteen molecules have been obtained. Known forbidden transitions to the helium 2^3S, the hydrogen $b^3\Sigma_u^+$, the nitrogen $A^3\Sigma_u^+$, $B^3\pi_g$, $a'^1\pi_g$ and $C^3\pi_u$, the carbon monoxide $a^3\pi$, the ethylene $\tilde{a}^3B_{1u}$, and the benzene $\tilde{a}^3B_{1u}$ states from the corresponding ground states have been observed. In addition, singlet–triplet vertical transitions in acetylene, propyne, propadiene, norbornadiene and quadricyclene, peaking at 5.9, 5.9, 4.5, 3.8, and 4.0 eV (±0.2 eV), respectively, have been observed and assigned for the first time. (auth)

11194 (LA–3783) CROSS SECTIONS FOR ELECTRON EXCITATION OF THE 3914-Å (0,0) BAND OF THE N_2^+ FIRST NEGATIVE SYSTEM. Holland, Redus F. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

As part of a study of the emission from nitrogen excited by an electron beam, cross sections for electron excitation of the 3914-Å (0,0) band of the N_2^+ first negative system were measured for electron energies of 95 to 2023 eV. Because published values for these cross sections differ by factors of two to three, an effort was made to establish the accuracy of the measurements. 3914-Å band intensity was measured with two independently calibrated photometers and a scanning spectrometer. A comparison of equipment and joint observations were made with experimenters from two other laboratories. The cross section obtained for the 3914-Å band at 95 eV is 1.5×10^{-17} cm^2, and that at 2023 eV is 3.1×10^{-18} cm^2. By a simple calculation, one can derive a corresponding efficiency of 4.3×10^{-3} for the production of the 3914-Å band by electrons in air. The excitation cross sections are in reasonable agreement with other recent measurements, but are higher than some values reported earlier. The calculated efficiency is in fair agreement with the results of laboratory efficiency measurements. (auth)

11195 (LA–3793) NEW MEASUREMENTS OF THE FLUORESCENCE EFFICIENCY OF AIR UNDER ELECTRON BOMBARDMENT. Hartman, Paul L. (Los Alamos Scientific Lab., N. Mex.). Aug. 1967. 25p. Dep. CFSTI.

The fluorescence efficiency of air under electron bombardment has been measured at a pressure corresponding to an altitude of 65 km, for electron energies near 700 eV, with the principal measurements at the bright 3914-Å band of the N_2^+ ion. Efficiencies for the 3914-Å band from two methods of observation were in good agreement, and gave a value $\eta_{3914} = 0.34\%$. Spectra were obtained for air emission in the range 2500 to 12,000 Å. Comparison of the radiation in the 3914-Å band to that in the whole spectrum gave a total efficiency of $\eta_{total} = 1.86\%$ for this spectral range. Efficiencies of some individual bands of the N_2 first and second positive systems were also determined by comparison with the 3914-Å band. The 3914-Å efficiency, for electron energies of 165 eV to 1 keV, was found to be nearly independent of energy, rising perhaps as the 0.07th power of the energy in this range. The dependence on pressure of the light output in the spectral range 3000 to 11,000 Å was observed for electron energies of 750 and 1425 eV and pressures of 30 to 960 μ. The efficiency of the 3914-Å band is independent of pressure below 100 μ. Above 100 μ, efficiencies of the N_2^+ first negative and N_2 first and second positive bands decrease with increasing pressure, the first positive decreasing most rapidly and the second positive least rapidly. Intensities of some N_2^+ Meinel bands were compared with the first positive (0,0) band at pressures of 1 to 50 μ in nitrogen and air. The intensity of the Meinel bands relative to the first positive band increases by an order of magnitude in going from nitrogen pressures of 50 to 1 μ. As a check on the photometric techniques, the cross section for excitation of the 3914-Å band by 750-eV electrons was measured and found to be in good agreement with results obtained by Holland. Some electron range measurements also gave results in agreement with previous work. (auth)

11196 (MATT-582) EXPERIMENTAL DETERMINATION OF ELECTRON IMPACT IONIZATION RATE COEFFICIENTS FOR NEON IONS. Mickey, D. L. (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1968. Contract AT(30-1)-1238. 63p. Dep. CFSTI.

Rate coefficients for collisional ionization of the ions Ne^{+} through Ne^{6+} were measured in several ohmically heated hydrogen discharges of the C stellarator, with 0.25 to 4% neon added. The electron densities were between 10^{12} and 4×10^{13} cm^{-3}; electron temperatures determined from the electrical conductivity of the plasma were between 8 and 100 eV. Neon ion densities were obtained as a function of time in the discharge from measurements of the intensities of resonance multiplets in each ion, on the basis of an assumed energy dependence for the excitation cross sections. The magnitudes of the excitation cross sections were determined from approximate oscillator strengths for the transitions, adjusted to give agreement with the known total neon density and with predicted populations of metastable terms. The metastable terms were found to have near-equilibrium populations, except in Ne^{5+} and Ne^{6+}, where equilibrium populations were observed only at high electron densities. Ionization rate coefficients deduced from the time dependence of the ion densities in discharges with different density and temperature behavior agree well, but the rate coefficients for higher stages of ionization are larger, and depend less strongly on temperature, than expected. The discrepancies are probably due to a moderate (≈15%) systematic error in the conductivity temperature, and to ionization cross sections which have maxima considerably nearer threshold than was assumed. (auth)

11197 (ORNL-TM-2030) LOW ENERGY ELECTRON STUDIES IN ALUMINUM. Nalley, S. J.; Nakai, M. Y.; Garber, F. W.; Ritchie, R. H.; Harter, J. A.; Birkhoff, R. D. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 61p. Dep. CFSTI.

Thesis. Submitted by S. J. Nalley to Univ. of Tennessee, Knoxville.

The dependence of the plasma excitation upon the angle of incidence of the primary beam to the surface was investigated using an ultrahigh-vacuum system to obtain cleaner surfaces. The effect upon these excitations of various amounts of secondary electron suppression was studied. A nearly monoenergetic beam of electrons was incident upon a thin (<300 Å) aluminum film deposited under ultrahigh-vacuum conditions (~10^{-9} torr) as the top layer of an $Al/Al_2O_3/Al$ diode. The currents from the top and bottom layers were then measured as a function of electron energy. The top current was expressed as a fraction of the total current and plotted versus the primary energy. The effect of various amounts of suppression voltage on the currents was investigated under normal vacuum conditions (10^{-6} torr). Substantial differences were noted which indicated that except at the lowest electron energies (<60 eV) and the highest (>500 eV), no electron transport took place across the top layer which could lead to traversal of the Al_2O_3 dielectric. (M.H.R.)

11198 (UUIP-558) ON THE TEMPERATURE DEPENDENCE OF THE INTENSITY OF THE $K\beta'$ SATELLITE IN Fe AND Ni. Eriksson, Elisabeth; Ekstig, Borje; Noreland, Erik (Uppsala Univ. (Sweden). Inst. of Physics). Oct. 1967. 13p. Dep.

The temperature dependence was studied of the $K\beta'$ satellite in Fe and Ni in secondary radiation. A quartz x-ray spectrometer was used. No temperature dependence was found in the region 300 to 1150°K. (auth)

11199 X-RAY ABSORPTION IN THE 2 TO 200 A REGION. Henke, B. L.; Elgin, R. L.; Lent, R. E.; Ledingham, R. B. (Pomona Coll., Claremont, Calif.). Norelco Rep., 14: 112-16 (July-Dec. 1967).

Physical and chemical analysis, x-ray astronomy, and high-temperature plasma diagnostics which utilize ultrasoft x radiations have shown the need for absorption coefficient data for the radiations between the conventional x rays and the extreme uv. More than 100 new coefficients were measured on the gas state, atomic or molecular, containing He, C, N, O, F, Ne, S, Cl, Ar, Kr, and Xe using 11 fluorescent, characteristic wavelengths Al-K_α (8.34 Å) through Be-K_α (113.8 Å). The radiations were isolated by Bragg reflection from multilayer analyzers of the Langmuir-Blodgett type and by pulse-height discriminating proportional counter intensity measurements. On the basis of these and previously published data, a table is provided for He through Ar and for wavelengths below the L(III) edges and in the region 2 to 200 Å. Absorption cross sections were calculated for many compound materials commonly encountered in low-energy x-ray analysis. The transmission of x rays from a source above the earth was tabulated as a function of altitude and wavelength. (BBB)

11200 ISOMER SHIFTS AND THE SELF-CONSISTENT CRANKING MODEL. Marshalek, E. R. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev. Lett., 20: 214-17 (Jan. 29, 1968). (COO-427-74).

Calculations are presented of charge radii of rotating nuclei based on the self-consistent cranking model. (M.O.W.)

11201 COHERENT ANTICROSSING SIGNALS. Budick, B.; Snir, J. (Hebrew Univ., Jerusalem). Phys. Rev. Lett., 20: 177-80 (Jan. 29, 1968).

Anticrossing signals have been observed in resonance fluorescence in which the two repelling levels are both excited from the same level in the ground state. The two anticrossed levels both decay to the same ground-state level as well. This extension of the anticrossing technique is successfully applied in a state of the hfs of the ytterbium atom. (auth)

11202 EFFICIENT SPUTTERING IN A COLD-CATHODE DISCHARGE IN MAGNETRON GEOMETRY. Wasa, Kiyotaka; Hayakawa, Shigeru (Matsushita Electric Industrial Co., Ltd., Osaka). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2179-80 (Dec. 1967).

Efficient sputtering has been achieved in a cold-cathode discharge in a magnetron geometry under a strong magnetic field. The sputtering may be readily used for the production of thin-film microcircuits. The mechanism of the sputtering is discussed in connection with the mode of discharge. (auth)

11203 SMITH-PURCELL RADIATION FROM A NARROW TAPE HELIX. Neureuther, A. R.; Mittra, R. (Univ. of Illinois, Urbana). Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2134-42 (Dec. 1967).

A theoretical investigation of a narrow tape helix excited by a modulated electron beam gives quantitative results which can be used to estimate the strengths of interactions obtainable in experimental configurations. Extensive results are presented for the radiation emitted by a single fast space harmonic when a slow beam is in synchronism with the azimuthally symmetric space harmonic. The effects of beam velocity, frequency, beam diameter, tape width, and pitch angle are illustrated. The analysis also demonstrates the influence of the synchronism or electromagnetic resonance condition on the interaction and, further, points out the usefulness of the complex Brillouin ($k-\beta$) diagram in predicting some of the quantitative as well as most of the qualitative properties of this influence. (auth)

11204 SMALL ENERGY SHIFTS IN X- AND γ-LINES AND SELECTION OF THE WAVELENGTH STANDARD IN X- AND γ RADIATION. Sumbaev, O. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 343-8 (Feb. 1967). (In Russian).

Since the existing wavelength standards are inherently variable, it is deemed necessary to consider the effects which may lead to energy shift in the x-ray emission lines and, therefore, dependence of the standard wavelength on the conditions of experiment. It is concluded that the γ transition with an observable Mössbauer effect at $f \approx 1$ would make a reasonable and convenient standard. (JPRS)

11205 CROSS SECTIONS FOR TRANSITIONS BETWEEN FINE STRUCTURE COMPONENTS OF SECOND GROUP EXCITED ATOMS INDUCED BY COLLISIONS WITH NOBLE GAS ATOMS. Voronin, A. I.; Kvlividze, V. A. (Inst. of Chemical Physics, Moscow). Theoret. Chim. Acta, 8: 334-40 (1967).

Some calculations of the cross sections for transitions between fine structure components of alkali metals in P-state for different collision pairs (Na*-Na, Na*-Ar, K*-K, K*-Ar, Cs*-He) have shown that exchange forces play an important role in nonadiabatic transition processes, and cross sections close to the experimental ones were obtained. This report considers the reactions of the type: $M^*(^3P_1) + X(^1S_0) \rightarrow M^*(^3P_0) + X(^1S_0) + \Delta\epsilon$. The electron excitation energy $\Delta\epsilon$ is transferred in kinetic energy of colliding pairs. M denotes any of the II-group P-state elements of the periodic table (Zn, Cd, Hg). X is a noble gas atom. When the cross sections of the transition $^3P_1 \rightarrow {}^3P_0$ for Zn, Cd, and Hg in collisions with inert gas atoms were calculated, it was shown that the transitions between fine-structure components induced by nonadiabatic interaction are due to rotation of the molecule. A numerical estimation of the cross sections was made. The corresponding quantum problem can be solved by a similar method. However, because of the lack of experimental data, this correction seems to be of no use at present. Although the cross sections are small, it is noted that they are measurable. The minimum cross section measured was of the order of ~10^{-21} cm^2 (for Cs + He pairs). (BBB)

11206 COMPUTER CALCULATION OF DEFLECTION ABERRATIONS IN ELECTRON BEAMS. Wang, Carl C. T. (IBM T. J. Watson Research Center, Yorktown Heights, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron Devices, ED-14: 357-65 (July 1967).

Aberrations of a magnetically deflected electron beam were investigated in detail using an IBM 7094 computer. Computer programming was applicable to the case of 2-dimensional deflection through small angles. The beam was treated as a group of electrons having no internal interactions, no energy spread, and producing no external fields. The field distributions that would produce minimum total aberration for a range of specified working distances, maximum deflection distances, coil widths, and coil openings were calculated. The aberrations produced by these ideal fields and by fields that deviated from the model were predicted. Typically, for a working distance of 3 in. (7.63 cm), field coverage of 11 mm, and beam convergence angle of 3.54×10^{-3} rad, the maximum increase in spot dia was ~0.05 μ. Theoretical limitations on the minimum aberration of a specific deflection system were established. The aberration was expected to be further minimized if dynamic astigmatic correction, as described, is applied. (BBB)

11207 TRANSMISSION COEFFICIENT OF ELECTRON BEAM THROUGH ONE-DIMENSIONAL FINITE CRYSTAL. **Tanji, Michio (Fukushima Medical Coll., Japan). Sci. Rep. Tohoku Univ., First Ser., 48: 151-65(June 1965).**

Transmission and reflection coefficients of an electron beam incident on a one-dimensional finite crystal were calculated assuming the potential energy of electron in the crystal as a square-well-type potential. The transmission coefficient T is affected by crystal thickness. T is dependent upon thickness in the energy range of the so-called allowed band, which is defined for the infinitely extended crystal with cyclic boundary condition. In the forbidden-band energy range, T decreases monotonously as the crystal becomes thick. A numerical example is given. (BBB)

11208 THREE-BODY RECOMBINATION OF POSITIVE AND NEGATIVE IONS. II. GENERAL THIRD BODY. **Bates, D. R.; Flannery, M. R. (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 302: 367-83(Jan. 9, 1968).**

A quasi-equilibrium statistical theory is used to investigate the low density limit to the rate of the three body ionic recombination process $X^+ + Y^- + Z \rightarrow [XY] + Z$, the interaction between the third body and an ion being taken to be of the Langevin form. It is shown that the recombination coefficient α is, to a close approximation, equal to the sum of two partial recombination coefficients, α_{13} and α_{23}, the former describing recombination due only to $X^+ - Z$ collisions and the later describing recombination due only to $Y^- - Z$ collisions. Results are presented which enable α to be found for a wide range of values of the temperature, the masses of the three species involved, the two Langevin hard-sphere radii, and the polarizability of the third body. In the case of equal masses (for which it was designed) the well-known theory of Thomson is remarkably successful with regard to its predictions on the dependence of α on the temperature and on the interactions. (auth) (UK)

11209 ATOMIC ORBITALS. **Norbury, A. H. Educ. Chem., 5: 28-32(Jan. 1968).**

Describing the slopes of atomic orbitals presents a number of problems. Several different ways in which the wave function may be represented are described, criteria for an adequate pictorial model are discussed, and some uses of models of the angular portion of the wave function are enumerated. (auth) (UK)

11210 ELECTRON CAPTURE BY FAST PROTONS IN IONIZED LITHIUM. **Ob'edkov, V. D.; Pavlov, V. E. At. Energ. (USSR), 23: 345-6(Oct. 1967). (In Russian).**

Although the cross sections for the above process have been measured, it is desirable to have a quantum mechanics evaluation of this cross section due to charge transfer on the residual gas in the chamber and other interferring processes. The cross section $\sigma(n)$ for single-electron capture in the reaction $H^+ + Li^+ \rightarrow H(n) + Li^{++}$ and also the total cross section $\sigma = \Sigma n\sigma(n)$ summed over all the quantum n states of the hydrogen atom are derived in this study. A comparison of the experimental cross sections versus the calculated cross sections showed qualitative agreement between the two sets of results. It would be desirable to extend the experimental results to higher electron energies in order to make a direct comparison. At lower energies the Born approximation is not applicable. (TTT)

11211 SCATTERING OF 15 TO 19 keV PROTONS IN THIN NICKEL FOILS. **Bodganov, G. F.; Lebedev, F. V. At. Energ. (USSR), 23: 347-8(Oct. 1967). (In Russian).**

The scattering probability of 15- to 90-keV protons per unit of solid angle $f(\theta)$ was measured as a function of scattering angle θ in the laboratory system of coordinates for nickel foils 10 to 90 $\mu g/cm^2$ thick at proton energies of 15, 30, 50, 70, and 90 keV. The proton beam was separated out by a magnetic analyzer, and struck the scattering foil fastened to a grid having a transparency of 70 to 80%. The particles emerging from the foil were not separated according to charge state, but were counted by an electron multiplier which was moved along an arc ~200 mm in radius. The results are in rather good agreement with the results obtained by Rutherford's scattering formula. The deviation between the two sets of results becomes greater with increasing foil thickness due to multiple scattering, which is difficult to take in account since the average number of scattering events varies over approximately a factor of ten depending on target thickness and proton energy. (TTT)

11212 ELECTROMAGNETIC RADIATION DURING ATOM–ION ORBITAL SCATTERING. **Faingol'd, M. I. (Inst. of Atomic Physics, Tashkent). Dokl. Akad. Nauk UzSSR, No. 10, 26-9 (1966). (In Russian).**

Scattering of charged particles induces bremsstrahlung; when calculating this effect, the contribution of the orbital motion must be also taken into account. The calculations may be conveniently carried out by approximation methods because the nature and the energy dependence of the orbital parameters are known; however, the frequency data are usually not available. The calculations carried out indicated that in the case of atom–ion scattering, the cross section of inelastic processes increases because of the reduction of the number of particles below the barrier in the internal potential region. The total radiation was found to increase at first with increasing energy if the residual background radiation is low. (TTT)

11213 ALGORITHM FOR THE NUMERICAL SOLUTION OF THE PROBLEM INVOLVED IN THE LOCATION OF PAIR PULSE SPECTRA IN THE CASE OF ANNIHILATION OF POSITRONS. **Arifov, P. U. (Physico-Technical Inst., Tashkent). Dokl. Akad. Nauk UzSSR, No. 4, 31-3(1967). (In Russian).**

The author showed in an earlier publication that the strict solution of the pulse spectra of the annihilation of electron–positron pairs from experimentally obtained angular correlation data of γ quanta leads to a Volterra-type integral equation. Some partial cases of the analytic solution of this equation were examined. The solution may be obtained by subsequent approximations in an infinite series. If the chosen value of the parameter derived from the effective impulse is sufficiently small, the series converges rapidly; however, this was not the case for most of the metals investigated by A. Stewart; the values reported by this author did not yield a smooth curve. Examination of his potential sources of error revealed that the derivative $dI/d\alpha^2$ must be determined, whereby $I(\alpha)$ designates the experimentally determined correlation function. The calculations were based on the least mean squares method, transposing Stewart's $I(2\alpha)$ function to the $I(\alpha^2)$ function and differentiating it by Lanczos's five-point method. The thus obtained values were compared with Stewart's data for sodium. (TTT)

11214 SPUTTERING DUE TO NEGATIVE OXYGEN IONS IN OXYGEN DISCHARGES. **Jennings, Thomas A.; McNeill, William (Frankford Arsenal, Philadelphia). Appl. Phys. Lett., 12: 25-6(Jan. 15, 1968).**

The effect of gaseous negative oxygen ion impact on an anode surface is examined. Gold films (≈300 Å) are sputtered at a pressure of 30 to 35 mtorr and at several anode voltages and currents. Results show a linear dependency of the sputtering rate on the applied anode voltage up to 95 V, while at higher voltages there is little change in the sputtering rate. The sputtering yield shows a decreasing nonlinear dependence on the applied anode voltage. The latter is explained in terms of the decrease in the electronegative character of the discharge. (auth)

11215 ELECTRON CAPTURE BY FAST PROTONS IN GASES. **Schryber, Urs (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 1023-51(Dec. 30, 1967). (In German).**

Measurements of different electron capture cross sections for fast protons in gases are reported. A proton beam from a Van de Graaff accelerator was conducted through a differentially pumped gas cell. The emerging beam was analyzed by a transverse magnetic field. From the neutral component the cross-section for electron capture σ_{10} in H_2, He, N_2, O_2, Ne, Ar, and Kr was measured for energies ranging from 1 to 4.5 MeV. From the measurement of the negative beam component the cross section for the capture of two electrons in a single collision, σ_{1-1}, as well as the cross-section σ_{0-1}, was deduced for H_2, He, N_2, and Ar in the energy range from 250 to 1000 keV. The results are compared with published theoretical estimates and experimental results. The cross section σ_{10} for protons in H_2 is found to be proportional to E^{-5} within the energy range of 200 keV to 3.3 MeV. For protons in He gas σ_{10} approaches asymptotically an energy dependence of E^{-6}. The variation of σ_{10} with energy for N_2 and Ar can be explained by electron capture from different shells. The energy dependence of the cross section σ_{1-1} for H_2 and He is approximately proportional to E^{-10} at an impact energy of 450 and 750 keV, respectively. (auth)

11216 EQUILIBRIUM CHARGE STATE FRACTIONS FOR 11.5 TO 37.3 MeV ^{16}O IONS IN CARBON. Brown, R. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Symons, G. D.; Hall, I. Nucl. Instrum. Methods, 58: 274-6(Jan. 1968).

The equilibrium charge state fractions for ^{16}O ions in carbon have been measured by magnetic analysis of ions scattered from a gold target backed by a carbon foil. Charge state fractions and rms ionic charges are tabulated. (auth)

11217 HYPERFINE INTERACTIONS IN THE GAS PHASE ELECTRON RESONANCE SPECTRUM OF $^{33}S^{16}O$. Carrington, Alan; Levy, Donald H.; Miller, Terry A. (Cambridge Univ., Eng.). Mol. Phys., 13: 401-7(1967).

Four fine-structure transitions in the gas-phase electron resonance spectrum of $^{33}S^{16}O$ were observed, and the ^{33}S magnetic hyperfine splitting was measured. Analysis of the spectrum led to values of the parameters describing the Fermi contact interaction and the electron–nuclear dipolar interaction. These are discussed in terms of the electronic structure of the radical. (auth)

11218 SCATTERING OF SLOW NEUTRONS BY ETHYLENE ADSORBED ON ACTIVATED CHARCOAL. Todireanu, S. (Inst. for Atomic Physics, Bucharest). Nuovo Cim., Suppl. (1), 5: 543-8(1967).

From International Symposium on Sorption-Desorption Phenomena in High Vacuum, Rome, Italy, Mar. 14–17, 1967. See CONF-670326.

Some results obtained in a slow-neutron spectrometry study of molecular motions in adsorbed ethylene are presented. The presence of a quasi-elastic peak in the spectra of 4-Å neutrons scattered at different angles, showed that at room temperature the adsorbed molecules have a diffusive motion along the surface. Near liquid nitrogen temperatures, a broad inelastic contribution in the spectrum might be associated with the vibrations and torsional vibrations of adsorbed molecules relative to the surface. (W.D.M.)

11219 RELATIVISTIC CORRECTIONS TO MANY-ELECTRON ATOMIC LEVELS. Braun, M. A.; Labzovskii, L. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz., 53: 1776-88(Nov. 1967). (In Russian).

A general procedure is proposed for calculating relativistic corrections to the levels of many-electron atoms in any order of perturbation theory. That part of the interaction which is due to exchange by high-energy photons is taken into account by means of an effective potential. A mixed gauge of the electromagnetic potentials is employed. Concrete expressions for the energy shift in the order α^3 Ry are presented. (auth)

11220 MEASUREMENT OF THE DEPTH DOSE DISTRIBUTION PRODUCED IN THICK TARGETS BY 0.5-, 1-, AND 2-MeV ELECTRONS. Aiginger, H.; Gonauser, E. (Atominstitut der Osterreichische Hochschule, Vienna). Atomkernenergie, 13: 33-7(1968). (In German).

The depth dose distributions produced by 0.5-, 1-, and 2-MeV electrons in Be, Al, Cu, Ag, and Au were measured with an air filled parallel-plate ionization chamber. The 0.5 MeV values were compared with the results predicted by the theory of Spencer. Diagrams show the characteristics of the distributions (depth of the maximum, extrapolated range, absolute ionization on the surface) versus the atomic number. From these diagrams the respective values of other elements can be derived by extrapolation. This makes the construction of their ionization distributions possible which are often necessary for the evaluation of irradiation experiments. The ratio of the surface ionization to the maximum ionization is 0.62 ± 0.03 for all electron energies and absorber materials. (auth)

11221 SEMICLASSICAL PHASE SHIFTS FOR LOW-ENERGY "ORBITING" COLLISIONS. Herm, Ronald R. (Harvard Univ., Cambridge, Mass. Univ. of California, Berkeley). J. Chem. Phys., 47: 4290-6(Dec. 1, 1967). (UCRL-17512).

A semiclassical expression for the phase shift in the literature which is applicable even when a maximum exists in the effective potential is re-expressed in terms of the simple JWKB phase integrals. This expression is employed to calculate phase shifts from tables of reduced functions for a Lennard-Jones (12-6) potential. These semiclassical calculations are compared with published exact values; excellent qualitative and good quantitative agreement is obtained. Finally, the qualitative nature of the quantal corrections to the classical total and differential cross sections and the collision lifetime is discussed. (auth)

11222 NONADIABATIC TRANSITION IN THE SLOW COLLISION BETWEEN HEAVY PARTICLES. Matsuzawa, Michio (Tokyo Univ.). J. Phys. Soc. Jap., 23: 1383-93(Dec. 1967).

Inelastic atom–atom collision is investigated under semiclassical condition by the use of perturbed stationary state method. Wave functions of the perturbed states of the system are expanded in terms of products of wave functions of isolated atoms. The expression for cross section is derived, using these wave functions. Dependence of the cross section on velocity is discussed. Further it is shown that the cross section is expressed only in terms of the exact adiabatic potentials concerned. The obtained formula is applied to electron capture by α particles in hydrogen. Results of calculation are discussed and compared with the experimental data by Fite et al. (auth)

11223 USE OF CORONA DISCHARGES FOR THE STUDY OF ION–MOLECULE REACTIONS. Shanin, M. M. (Xerox Corp., Rochester, N. Y.). J. Chem. Phys., 47: 4392-8(Dec. 1, 1967).

Low-pressure positive corona discharges have been developed for studies of ion–molecule reactions at pressures which exceed those used in conventional high-pressure mass spectrometry by several orders of magnitude. The reactions occurring within the discharge are studied by means of a mass spectrometer, sampling the ionic species which arrive at the cathode. Studies made in a system of nitrogen and trace quantities of either water vapor or oxygen have shown the importance of both ion–molecule reactions and charge-exchange processes which occur in atmospheric gases. The cross sections for a number of these processes with ions of near thermal energies have been measured. (auth)

11224 ELECTRON-IMPACT IONIZATION CROSS SECTIONS. IV. GROUP IVb ATOMS. Lin, Sin-Shong; Stafford, Fred E. (Northwestern Univ., Evanston, Ill.). Contract AT(11-1)-1147. J. Chem. Phys., 47: 4664-6(Dec. 1, 1967). (COO-1147-16).

The electron-impact ionization cross sections for Ag, Ge, Sn, and Pb have been measured relative to one another by quantitatively vaporizing known amounts of material in a mass spectrometer. For 60-eV impacting electrons, the relative single ionization cross sections are found to be (1.00), 1.46 ± 0.3, 1.46 ± 0.16, and 1.43 ± 0.1, respectively. The corresponding secondary-electron multiplier gains for 6.4-keV ions are (1.00), 1.04, 1.03, and 0.79, all ± 5%. These experimental cross-section ratios are compared to the best available calculated values. From the absolute cross section for Pb of Beilina et al., that for Ag is 5.6×10^{-16} cm^2. (auth)

11225 ELECTRON-IMPACT IONIZATION CROSS SECTIONS FOR SILVER. Crawford, C. K.; Wang, K. I. (Massachusetts Inst. of Tech., Cambridge). Contract AF 33(657)-10939. J. Chem. Phys., 47: 4667-9(Dec. 1, 1967).

Absolute electron ionization cross sections have been measured for silver using a single-crossed-beam method. A silver beam was generated by vaporizing silver shot in a small high-temperature Knudsen cell, and passed through an ionization chamber where it intersected an electron beam at right angles. By applying suitable potentials to the chamber, ions could be accelerated either into a Faraday-cup total-ion collector, or into a large quadrupole mass spectrometer. After passing through the chamber, the silver beam was condensed in a weighable atomic-beam trap. Absolute cross sections were obtained by integrating the total-ion collector current, and calculating the silver beam intensity from the weight increase of the trap. The measured values at 75 eV are $(4.65 \pm 1.0) \times 10^{-16}$ cm^2 for the formation of Ag^+ and $(4.75 \pm 3.0) \times 10^{-17}$ cm^2 for the formation of Ag^{2+}. The value for Ag^+ agrees within experimental error with the extrapolated experimental values of other workers, but disagrees with theoretical predictions. (auth)

11226 EQUILIBRIA IN HYDROGEN–TRITIUM MIXTURES. STEADY STATES AND INITIAL REACTION RATES AT 76.7°K. Jones, Wesley M. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 47: 4675-9(Dec. 1, 1967). (LA-DC-8897).

H_2, T_2, and HT are brought to thermodynamic equilibrium by the tritium β particles at 299 and 192°K if precautions are taken to minimize impurities; otherwise the steady-state quotient, $Q = (HT)^2/(H_2)(T_2)$, tends to be higher than the equilibrium constant K. At 192°K the initial reaction rates in H_2-T_2 mixtures correspond to about 3000 molecules reacting per ion pair. The results can be understood in terms of the thermal ion–molecule chain reactions of Thompson and Schaeffer. If the chains are shortened by impurities, the importance of hot processes tending to make $Q > K$ is emphasized. The hot processes may be hot atom–molecule reactions caused by hot atoms formed by the recombination of H_3^+ ions (chain-breaking step). At 76.7°K the behavior is quite different. Initial reaction rates correspond to only about 20 molecules reacting per ion pair. Q is in general significantly higher than K(76.7°K) = 0.63 and approaches K only in the limits of zero pressure or zero tritium content. This behavior is discussed in terms of short thermal ion–molecule chains and of hot processes resulting from the products of recombination of H_3^+ ions. The importance

of the hot processes seems to be determined by a competition between wall and volume recombination. (auth)

11227 AUTOIONIZATION OF HIGHLY EXCITED Ar^+ IONS PRODUCED BY ELECTRON IMPACT. Newton, Amos S.; Sciamanna, A. F.; Clampitt, R. (Univ. of California, Berkeley). J. Chem. Phys., 47: 4843-9(Dec. 1, 1967).

The $(M/q)^+ = 10$ peak in the mass spectrum of argon observed at ionizing electron energies of 40 to 120 eV (uncorr.), is shown to consist of approximately equal contributions from: (1) surface-induced transitions of an excited Ar^+ ion to Ar^{2+} at the last ion-source slit, and (2) an autoionization of an excited Ar^+ ion after the last ion-source slit. By use of an auxiliary slit beyond the last normal ion-source slit, these two processes were separable, and it is shown that the excited state undergoing surface-induced transitions is a different state than that undergoing autoionization, with the autoionizing state having an A.P. of 0.5 ± 0.2 eV higher than the state undergoing surface-induced transitions. The existence of autoionizing states of Ne^+ and Ar^{2+} was also confirmed. (auth)

11228 TRANSVERSE OPTICAL PUMPING AND DETECTION OF MODULATION RESONANCES IN ^3He. Donszelmann, A.; Van Der Berg, C. J.; Voetelink, P. (Zeeman Laboratorium, Amsterdam). Phys. Lett., 26A: 83-5(Dec. 18, 1967).

In a modulated magnetic field the transfer of coherence due to collisions to and from the ground state is observed in an optical-pumping experiment. A theoretical explanation of the phenomenon is pointed out. (auth)

11229 THE EXCITATION OF Fe XVII BY ELECTRON IMPACTS. Bely, O.; Bely, F. (Observatoire de Nice, France). Solar Phys., 2: 285-9(Nov, 1967).

The cross sections for the excitation of Fe XVII are computed using the Coulomb–Born approximation. For the excitation of the configurations $2p^5$ 3s, $2p^5$ 3p, and $2p^5$ 3d, the intermediate-coupling scheme is used, while an extrapolation is made for the excitation of the 2s $2p^6$ 3s, 2s $2p^6$ 3p, and 2s $2p^6$ 3d configurations from the results obtained earlier in the lithium-like ions. It is found that the excitation cross section Q ($2p^6\ ^1S_0 \rightarrow 2p^5\ 3p\ ^1S_0$) is fairly large and partly removes the disagreement between the theoretical and experimental intensity-line ratios. (auth)

11230 REACTIONS OF Hg (6^3P_0) ATOMS IN THE PRESENCE OF NITROGEN. McAlduff, Joseph Edward. Toronto, Univ. of Toronto, 1966.

Thesis.

Metastable Hg 6^3P_0 atoms were produced in a flow system by reaction of Hg 6^3P_1 atoms with N_2. The relative steady-state concentration of Hg 6^3P_0 atoms was studied as a function of Hg 6^1S_0 and N_2 by absorption spectrometry. Rate constants have been obtained for deactivation of Hg 6^3P_0 to the ground state and for its activation to the Hg 6^3P_1 state by collision with nitrogen. The radiative lifetime of Hg 6^3P_0 has been found to be 7.5×10^{-3} sec. It has been shown that spontaneous emission of the "forbidden" line 2656.4 Å is of relatively minor importance in the removal of Hg 6^3P_0 under the experimental conditions. Evidence has also been obtained for a reaction of Hg 6^3P_0 atoms with Hg 6^1S_0 atoms to form a relatively long lived diatomic species. This process involves stabilization by collision with nitrogen. As a consequence of obtaining rate constants for the various reactions of Hg 6^3P_0, it is possible to predict the ratio of Hg 6^3P_0 to Hg 6^3P_1 for any given concentration of N_2 and Hg 6^1S_0. (Disser. Abstr.)

11231 STUDY OF THE REACTION BETWEEN DEUTERIUM ATOMS AND BROMINE MOLECULES USING CROSSED MOLECULAR BEAMS. Schmidt, Thomas William. Knoxville, Tenn., Univ. of Tennessee, 1967. 80p.

Thesis.

A molecular beam apparatus designed to study gas-phase reactions was used to investigate the reaction between deuterium atoms and bromine molecules. A special feature of this apparatus was the scattering chamber. It allowed the detector mounted outside the scattering chamber to be rotated 130° around the scattering center without disturbing the vacuum. The walls of the scattering chamber were three concentric cylinders. The central cylinder was stationary while the others rotated on it. Stability in the rotation was provided by bearings between the cylinders, and the vacuum seal was made with O-rings. Other features were a quadrupole mass filter detector with an electron bombardment ion source, differential pumping on the detector, a liquid nitrogen cooled radiation shield around the ion source, and a bakeable detector assembly. The deuterium atom primary beam was formed in a tungsten oven source at 3000°K. It was modulated at 100 Hz and crossed with a 325°K bromine beam. The modulator also triggered a switching circuit, which, when properly phased with the beam, sent the signal from the detector to one counter when the beam was on and to another when the beam was off. The in-plane angular distribution of deuterium bromide product was measured and found to agree very well with the theoretically predicted distribution of centroids. Also measured were the reactive collision yield, 0.097 ± 0.02, and the absorption cross section, $(100 \pm 7) \times 10^{-16}$ cm^2. The close agreement of the measured and theoretical product angular distribution along with the reactive collision yield and the absorption cross section, indicate that at least 0.1 of the deuterium bromide produced is internally excited by an amount which equals 99% of the total available energy (48.2 kcal/mole). By applying the laws of classical mechanics to the collisions studied, estimations were made on the effects of impact parameters in the distribution of internal energy in the product molecules. (Disser. Abstr.)

11232 PERFORMANCE OF AN ARC-HEATED SUPERSONIC MOLECULAR BEAM AND ITS APPLICATION TO MOLECULE–MOLECULE COLLISION STUDIES. Kuluva, Neil Marshall. Los Angeles, Univ. of California, 1967. 131p.

Thesis.

Properties and design characteristics of a 1-eV, arc-heated, supersonic, argon molecular beam were studied analytically and experimentally. Preliminary measurements of argon–argon scattering at relative energies of 1 eV were conducted. The molecular-beam system studied consists of four main chambers. The stagnation chamber (plasma head) contains an arc between two electrodes for adding energy to the argon gas as it passes through. The gas then leaves the stagnation chamber through a sonic nozzle and expands in the form of a free jet into the source chamber wherein the majority of the gas molecules are pumped away by a booster diffusion pump. The central core of the free jet then passes through a conical skimmer into the collimating chamber and the beam is thus formed. Often a beam chopper, a velocity filter, or a scattering chamber is mounted in the collimating chamber to facilitate particular experiments. The beam finally passes through a small orifice (usually 1.27 cm in diameter) into the detection chamber where the detector and various auxiliary equipment are housed. Background pressures realized in the source, collimating, and detection chambers are nominally several microns, 5×10^{-5} torr, and 10^{-6} torr respectively. The molecular beam density, energy, and velocity distribution were studied experimentally. The measured beam densities were correlated with those predicted using a sudden-freezing model of the free jet. Although the data confirmed the usefulness of this model, extensive deviations of measurements from predictions, due in part to an inadequate description of background scattering in the source chamber, were observed. The maximum beam density measured was 3×10^9 molecules/cm^3 at 180 cm from the skimmer resulting in an intensity of about 2×10^{19} particles/steradian/sec for a beam speed of 2×10^5 cm/sec. Calculations show that, by proper choice of beam parameters, the intensity for a Mach-10 beam with a stagnation temperature of 5700°K may be improved to about 3×10^{20} particles/steradian/sec. (TSS) (Disser. Abstr.)

11233 LOW-ENERGY SPUTTERING STUDIES. Woodyard, James Robert Joseph. Newark, Del., Univ. of Deleware, 1966. 180p.

Thesis.

Experimental and theoretical studies of low-energy (0- to 100-eV) sputtering were conducted. A low-pressure magnetically confined arc discharge was used in a mass spectrometer ion source to study the sputtering of neutral Cu particles from a polycrystalline target by Ar^+. The method produced a sensitivity of 7×10^{-4} atoms/ion. Cu atoms were detected down to a bombarding Ar^+ energy of 27 eV; Cu_2 molecules were detected down to 50 eV. The mass ratio of analyzed Cu_2 molecules to Cu atoms increased with Ar^+ energy to about 5½% at 100 eV. Yield curves agree well with results of other investigators. The ejection patterns and sputtering yield resulting from Ar^+ bombardment of Ag (100) near threshold were studied using an optical detection-of-deposits method. Sputtered particles were detected down to an ion energy of approximately 23 eV. No sputtered particles were detected at approximately 18 eV with a sensitivity of 3×10^{-5} atoms/ion. The ejection patterns showed that sputtering becomes even more preferential at ion energies near threshold. The bombarding-particle energy transfer to the lattice was studied by using reasonable repulsive potential functions and considering important collision sequences. The role of the mass ratio of the bombarding particle and the target atom was investigated. It was found that n-body effects result from simultaneous collisions and not from long collision lengths. It is shown that the rebounding mechanism is not valid. The calculations suggest that the bombarding-particle energy loss tends to become complete at low energies. The results are independent of the bombarding particle and target atom mass ratio. (Disser. Abstr.)

11234 CONCEPT OF LOCALIZATION IN THE INDEPENDENT-PAIR MODEL OF ELECTRONIC STRUCTURE AND ITS

APPLICATION TO THE BERYLLIUM ATOM. Ludena, Eduardo Vicente. Cleveland, Case Inst. of Tech., 1966. 91p.

Thesis.

The viewpoint that the natural framework for the discussion and calculation of electron correlation energies is based on the concept of localized electronic wave functions is analyzed and adopted as a basis for deriving equations for a correlated trial wave function within the context of the independent-pair model. Arguments based on the localization concept justify the neglect of coupling matrix elements that appear in the Bethe–Goldstone equations. Simplified equations are obtained and applied to the calculation of the correlation energy of the beryllium atom. An expansion of the correlation term X(1,2) up through powers of r_{12}^{-1} gives 98.5% of the total correlation energy of Be. This represents a value comparable with the best reported to date and is one obtained by considerably less computation. (TSS) (Disser. Abstr.)

11235 TOTAL SCATTERING CROSS SECTIONS IN MOLECULAR BEAMS. Gislason, Eric Arni. Cambridge, Mass., Harvard Univ., 1967. 192p.

Thesis.

Total cross sections were measured for scattering of velocity-selected beams of alkali halide molecules KCl, CsCl, and CsBr by Kr, Xe, HBr, and CH_3I. The results indicate that rotationally inelastic transitions produced by the angle-dependent dipole–dipole potential dominates the scattering provided the rotational spectra of the two colliding molecules overlap strongly. The velocity dependence of the alkali halide–CH_3I scattering is much weaker than for the elastic scattering of alkali halide–rare gas systems. Because of the finite angular resolution of the apparatus, it was necessary to correct the results. This requires a knowledge of the small-angle scattering for dipole–dipole systems. Approximate formulas were obtained using a semiclassical analysis along with a Born approximation for the scattering matrix. Resolution corrections were then evaluated for dipole–dipole systems. A general treatment of angular resolution corrections is described for spherically symmetric r^{-3}, r^{-4}, r^{-6}, and r^{-12} potentials. The effects of the scattering gas velocity distribution are included explicitly. An experimental test of the theory is included, and precise values of the total cross sections for Na, Rb, and Cs scattered from Ar, Kr, and Xe were measured relative to K scattered by the same gas. Good agreement with recent theoretical calculations is obtained. The velocity dependence of total cross sections has been measured for the scattering of Na atoms from CBr_4, Br_2, $SnCl_4$, CCl_4, CH_3I, SF_6, and $SiCl_4$. All the systems show the expected $v^{-\frac{1}{3}}$ velocity dependence due to the r^{-6} dispersion potential, but the "glory undulations" associated with the potential well appear only for Na + SF_6. The results are interpreted in terms of the reactivity and structure of the polyhalide molecules. (Disser. Abstr.)

11236 TWO PROBLEMS IN ATOMIC THEORY. Garcia, Jose Dolores Jr. Madison, Wis., Univ. of Wisconsin, 1966. 86p.

Thesis.

Two separate problems and a related computation are discussed. First, the problem of radiative corrections to the ground-state energies of atoms and molecules is discussed, and an approximate method for obtaining these corrections is presented. This method, which is based on the use of the oscillator strength sum rules, is tested on the hydrogen and helium ground states, where the corrections are quite precisely known, then applied to the hydrogen-molecule and lithium-atom ground states. The method can also be used to obtain the average excitation energy or stopping power for high-energy collisions. This quantity is also calculated for the above-mentioned systems. The method appears capable of accuracies of a few percent. The second problem involves a consideration of multiply excited states of the lithium atom. The observed spectrum of that atom contains at least four narrow-line complexes that cannot be attributed to the normal one-electron spectrum of the atom or ion. Since all multiply excited states are subject to autoionization, the lifetime of a state can be used to determine whether that state can contribute to narrow-line radiation. It is found that no triply excited state can contribute to narrow-line spectra. However, there is a class of doubly excited states of the nonrelativistic Hamiltonian that is stable with respect to autoionization in the limit of pure LS coupling. These states can participate in narrow-line radiation, and the unidentified lines are found to be plausibly classifiable as transitions among these states, on the basis of screening theory estimates of the energies. An additional computation, consisting of energy-level and line tables for one-electron atomic spectra, with sufficient accuracy to include all known quantum-electrodynamical corrections, is included. The work was undertaken at the request of the National Research Council for inclusion in the revised National Bureau of Standards Atomic Energy Level Tables. Recent measurements of the Lamb shifts in hydrogen, deuterium, helium, and lithium are compared with the tabulated values; the calculated values are seen to give the shifts to one part in ten thousand. (Disser. Abstr.)

11237 MEASUREMENT OF EXCITED STATE LIFETIMES. Kindlmann, Peter Juergen. New Haven, Yale Univ., 1966. 197p.

Thesis.

Measurements were made of the radiative lifetimes and total destructive collision cross sections in helium, neon, and singly ionized argon. The data are sufficiently accurate to permit meaningful checks on the accuracy of various theoretical calculations. A phase-locked vernier chronotron was designed for accurate determination of lifetimes by a photon-counting technique. A scheme for excited-state formation by impact with threshold-energy electrons was developed to eliminate errors due to cascade effects. To the best of our knowledge, these are the only such threshold measurements to date on the above mentioned atomic species. Previous measurements of the destructive collision cross sections have been virtually nonexistent. The six major sections of the paper deal with the pertinence of these measurements to laser systems and the theoretical background; previous methods of measurement; a review of delayed multichannel coincidence techniques; the present experimental method; data analysis; and the discussion of our results. (Disser. Abstr.)

11238 VARIATIONAL CALCULATION OF 2-, 3-, AND 4-ELECTRON ATOMS USING INTERELECTRONIC COORDINATES. Gibbs, Richard Lynn. Potsdam, N. Y., Clarkson College of Tech., 1966. 91p.

Thesis.

Calculations of ground-state energies and a number of atomic parameters for the helium (Z = 1, 2, 3, 4, 5, 6), lithium (Z = 3, 4, 5, 6), and beryllium (Z = 3, 4, 5, 6) isoelectronic sequences are presented. The wave functions are written in the Jastrow form, are analytic and the parameters are determined via the variational principle. The orbital exponents and correlation coefficients are simultaneously optimized for all cases. A method for evaluating the atomic matrix elements in closed form is also presented. The integrals may be evaluated by using a tensor operator formalism and a well known two-electron integral. Values of the atomic molar diamagnetic susceptibility and diamagnetic nuclear shielding constant are also determined for the atoms and ions considered. (Disser. Abstr.)

11239 APPLICATION OF MANY-BODY THEORY TO THE PROBLEM OF SPECTRAL LINE SHAPES. Zaidi, Syed Haider Raza. Knoxville, Tenn., Univ. of Tennessee, 1967. 147p.

Thesis.

The purpose of a spectral line shape theory is to predict the shape of the spectrum of the electromagnetic radiation absorbed (or emitted) by a material system in terms of microscopic and macroscopic properties of the system. A general formulation of the absorption spectrum problem has been obtained by using a many-body approach. By consideration of several special cases it is shown that most of the results of the simple theories can be recovered from the general formulation. Higher order effects and new situations, not covered by simpler theories, can also be treated systematically. Moreover, Feynman diagram techniques provide a very elegant method of calculation. First a spectral formula based on a zero order solution of the integral equations is applied to the following special cases: (1) Doppler broadening; (2) self-broadening; (3) foreign broadening; (4) polarization effect in electron broadening; and (5) phonon broadening in a crystal. The familiar Doppler-broadening formula is recovered. Part of the result of the impact theory can also be obtained within the zero order framework. Some higher order solutions of the integral equations are also obtained. In particular the special case of two-level resonant self-broadening is considered in detail. It is shown that if the lower level is the ground state, the multiple transfer of excitation is very important and the result of the impact limit is not sufficient. At low densities, the contribution of the multiple transfer is proportional to the number density. The line shape is still Lorentzian (neglecting Doppler broadening) but the additional temperature dependent width and shift should be relatively important. (Disser. Abstr.)

11240 EXACT ANALYSIS OF AN INTERACTING FERMI GAS: THE TWO-SPIN DEVIATE PROBLEM. Flicker, Michael. New York, Yeshiva Univ., 1966. 95p.

Thesis.

A gas of one-dimensional Fermi particles with spin interacting via a repulsive delta-function potential has been solved exactly. The energy of the ground state and low lying excited states has been calculated explicitly for $S^z_{total} = N/2 - 2$. All the eigenfunctions and energies can be found. It is believed that this technique can be used to determine the energies and eigenfunctions for all values of S^z_{total} from 0 to N/2. (Disser. Abstr.)

Cosmic Radiation

Refer also to abstracts 10559, 10564, 11169, and 11566.

11241 SEARCH FOR PARTICLES WITH FRACTIONAL CHARGE ≥ ⅓e IN COSMIC RAYS. Kasha, H. (Brookhaven National Lab., Upton, N. Y.); Larsen, R. C.; Leipuner, L. B.; Adair, R. K. Phys. Rev. Lett., 20: 217-19(Jan. 29, 1968). (BNL-12027).

The flux of relativistic particles with a charge ≥ ⅓e was measured in cosmic rays at sea level using a scintillation counter hodoscope. An upper limit equal to 1.3×10^{-10} cm^{-2} sr^{-1} sec^{-1} was established at 90% confidence level. (auth)

11242 THE 27-DAY VARIATIONS OF COSMIC RAYS WITH RESPECT TO THE SOLAR AND GEOMAGNETIC ACTIVITY. Alaniya, M. V.; Dorman, L. I.; Shatashvili, L. Kh. (Inst. of Geophysics, Tbilisi, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1864-6(Nov. 1966). (In Russian).

The nature of the amplitude changes of the 27-day modulation of the neutron component of cosmic rays during a period of decrease of the solar activity was examined by studying the Forbush depression and the modulation of cosmic radiation while they exhibited the same period as the revolution of the Sun. Data of the neutron component reported by the Climax and Norikura Stations during 80 and 70 rotations, respectively, of the Sun were used for the investigation. It was found that the effective width of plasma streams due to the 27-day variation of the cosmic rays is larger for the relatively low-energy particles than for the high-energy ones. The spectrum of the 27-day variations changed from one rotation of the Sun to the other. The width of streams causing these variations does not seem to depend on the phase of the solar activity cycle; only the power of the corpuscular stream is affected. (TTT)

11243 SPECTROGRAPHIC MEASUREMENT OF THE VARIATION OF COSMIC RAYS BY MEANS OF ABSORPTION IN THE ATMOSPHERE. Dorman, L. I.; Sergeev, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1867-9(Nov. 1966). (In Russian).

The coupling factor method makes it possible to determine the energy spectrum of primary cosmic radiation by measuring the variation of the secondary components at various altitudes in the atmosphere. The secondary variation of extraterrestrial origin may be derived by means of a formula which includes terms defining the generation of secondary particles by primary particles possessing a given cutoff rigidity. In the first approximation, changes in the variation may be also determined from the exponential law but with the stipulation that the barometric variation depends on the nature of the primary variation. The calculation showed that the simultaneous observation of the radiation at various altitudes may be considered as a special kind of spectrographic measurement. (TTT)

11244 PRELIMINARY RESULTS OF THE STUDIES OF THE 1965 SIBERIAN EXPEDITION ON THE SPATIAL RIGIDITY DISTRIBUTION OF COSMIC RAY INTENSITIES. Granitskii, L. V.; Dorman, I. V.; Dorman, L. I.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1870-2(Nov. 1966). (In Russian).

The intensity of secondary neutron components within the 0.3 to 10 BV cutoff rigidity range was measured during the period from July 27 to Nov. 1, 1965. The expedition followed a water route (Krasnoyarsk-Dudinkina-Murmansk-Kandolaksha-Cherepovets-Gor'kii-Evportoria) and the rail line (Tbilisi.-Ashkhabad-Kushka-Tushkent-Alma-Ata-Agaguz-Novosibirsk). The instruments used included a telescope with mutually perpendicular counters, neutron monitors and radioprobes with counters. It was found that the intensity from 4 BV toward the lower rigidities decreases both for the generally ionizing and for the hard component. This may be due to the temperature effect and to the intensity anisotropy of the high-energy particles; no such effect was noted in the neutron component. The latitudinal behavior of the neutron component agreed with the authors' earlier observations. (TTT)

11245 DETERMINATION OF THE COUPLING FACTORS OF THE NEUTRON COMPONENT OF COSMIC RAYS ON THE BASIS OF DATA OBTAINED ON BOARD THE SCHOONER "ZARYA." Dorman, L. I.; Okulov, Yu. I.; Kaminer, N. S.; Manshilina, A. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1873(Nov. 1966). (In Russian).

The latitude dependence data of the intensity of the neutron component, measured during the period from August 1959 to May 1960 on board the schooner "Zarya" were used to calculate the rigidity cutoff function values reported by J. J. Quenby and W. R. Weber. The ship followed the route leading from Odessa to Colombo, Hobart, Wellington, and Vladivostok. Plotting the intensity of the neutron component as a function of the rigidity, it was found that the difference of the latitude-dependence curves for the northern and southern hemispheres becomes smaller if T. Makino's rigidity data are used. The author's earlier formula was employed to calculate the coupling factor for the 4- to 17-BeV energy range. The factors obtained differed from the author's earlier values. (TTT)

11246 EXPERIMENTAL DETERMINATION OF COUPLING FACTORS FOR THE OBLIQUE COMPONENT OF COSMIC RAYS. Mazaryuk, E. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1874-5(Nov. 1966). (In Russian).

Even though the coupling coefficient for the oblique component of cosmic rays can be calculated, they must be also experimentally determined. This may be done by plotting the latitude dependence of this component. Such measurements were carried out during December 1964 by means of crossed telescopes on board the steamer "Estonia." Details of the technique were given in the author's earlier publication. The course of the ship, from Gibraltar to Australia, followed mostly a northwest to southeast direction. The results of the measurements were used to calculate the vertical and the 30° components. Unfortunately, the precision of the measurements was not very high. (TTT)

11247 THE LATITUDE EFFECT OF COSMIC RAYS DETERMINED ON THE BASIS OF STRATOSPHERIC MEASUREMENTS DURING 1964–1965. SPECTRUM OF THE ELEVEN-YEAR VARIATIONS. Dorman, L. I.; Kovalenko, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1876-8 (Nov. 1966). (In Russian).

Measurement of the latitude dependence of cosmic radiation in the stratosphere makes it possible to determine the primary spectrum type in the low-energy range and to calculate the bond factors which are required when passing from the observed secondary variations at various depths of the atmosphere to the variations of the primary stream. During 1964 and 1965, cosmic-ray intensity measurements were carried out in the 0.5- to 3.5- and 0.3- to 10-BV range, respectively, using identical radio probes and counters. It was found that the intensity of particles with cutoff rigidity R < 3 BV was increased during 1965, although the minimum of the solar activity was reached during the summer of 1964. This is due to the inertia of the 11-year variation mechanism, i.e., to the delay in the regeneration of the intensity of cosmic rays with respect to the minimum of the solar activity. The latitude effect data were used to calculate the bond factors. (TTT)

11248 DEUTERONS IN COSMIC RADIATION. Kuzhevskii, B. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1786-8(Nov. 1966). (In Russian).

The role of the $p + p \rightarrow d + \pi^+$ reaction in the formation of galactic cosmic radiation was examined. The cross section of this reaction is in the 0.34- to 2.8-BeV range, increasing rapidly as the kinetic energy increases from 340 to 600 MeV; this is followed by an exponential decrease. The differential energy spectrum was also investigated. The low-energy proton spectrum beyond the limits of the solar system, I_p^0 (T) is determined by the expression $I_p^0(T) = I_p(T) \exp(0.8/\beta)$, whereby β represents the ratio of the speed of protons and the speed of light. The proton ionization losses in the range of interest are negligible. In the 370- to 2800-MeV range, the deuterons formed possess a kinetic energy from 90 to 700 MeV nucleon^{-1}. The range above 3 BeV was not taken into account because on the Earth this field represents less than 5% of the expected flux. A comparison of the deuteron fluxes obtained by the $p + p \rightarrow d + \pi^+$ reaction and by fragmentation indicated that the p + p reaction cannot be neglected in the 150- to 700-MeV nucleon^{-1} range as a deuteron source for galactic cosmic radiation. (Review article, 13 ref.). (TTT)

11249 POSSIBILITY OF INVESTIGATING THE PRIMARY COSMIC RADIATION INTENSITY ON THE BASIS OF TRACKS OF NUCLEAR PARTICLES IN METEORITES AND TEKTITES. Kashkarov, L. L.; Genaeva, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1799-1801(Nov. 1966). (In Russian).

The tracks of heavy charged particles passing through solid dielectrics may be observed microscopically after etching the material; the principle parameter involved in the observation of the tracks in the mean specific energy loss of the particles, $(dE/dx)_{crit}$. On this basis the charge of the nuclei creating the tracks may be identified making it possible to use the method to investigate the heavy-particle intensity of primary cosmic radiation. The mean components of this radiation, hydrogen and helium nuclei, do not generate tracks; very low fluxes may be measured by mica detectors placed on satellites. The tracks do not disappear when the tektites are heated up to 200°C. The main sources of the tracks are (a) the products of the spontaneous fission of ^{238}U and ^{244}Pu; (b) fission of heavy elements due to protons from primary cosmic radiation; (c) the neutron-induced fission of

uranium; (d) recoil nuclei from these reactions; and (e) recoil nuclei with A ≳ 30 in the cosmic rays. Moldavite and philippinite specimens were microscopically examined after etching them with 40% HF. It was found that some of the tracks represent cases of triple fission. The probability of the appearance of such tracks probably due to high-energy protons is about 10^{-3} of the tracks due to spontaneous fission of uranium. The rate of formation of these threefold tracks by high-energy protons could be determined experimentally on a proton accelerator. (TTT)

11250 SPACE AND TIME CHARACTERISTICS OF ELECTRON STREAMS PENETRATING THE EARTH'S ATMOSPHERE IN THE AURORAL REGIONS BY MEANS OF RIOMETRIC AND STRATOSPHERIC MEASUREMENTS. Lazutin, L. L.; Charakhch'yan, T. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1802-3(Nov. 1966). (In Russian).

Many of the geophysical phenomena observed at high latitudes are due to the penetration of electron streams, with energies ranging from one to several hundreds of keV into the atmosphere. These streams increase the ionization in the lower layers of the ionosphere, resulting in increased magnetic excitation, aurora, and bremsstrahlung effects. The time and space characteristics of these streams were studied by means of the RK-1 and RK-4 radio probes at the time of minimum solar activity, using G–M counters for recording, and riometers for measuring the cosmic radio noise. The histograms taken during the period from March to June 1965, during ascent, descent, and steady-state operations indicated that the absorption lasts from 2 to 5 hours. Bursts of x radiation exhibited a similar behavior. The penetrations occur primarily at night and during the early morning hours. In order to understand the properties of the electron stream penetrations in the auroral regions, such as variability, duration, and longitudinal coverage, the electron acceleration mechanisms must be further studied. (TTT)

11251 X-RAY BURST AND THE AURORA. Lazutin, L. L.; Roldugin, V. K. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1804-6 (Nov. 1966). (In Russian).

During the winter of 1964-65, the aurora was studied photometrically at the Loparskaya Station, determining simultaneously the cosmic-ray intensity at the Apatity Station. The photometer with a viewing angle of 70° was set at the zenith; the ionizing component at the stratosphere was measured by a counter. During the night of Feb. 3–4, 1965, the complementary radiation in the stratosphere and the aurora were recorded simultaneously. The continuous cloud cover did not allow direct visual observation. It was also noted that the increase of the x radiation in the stratosphere and the intensity of the aurora coincided closely. It may be concluded from the absence of riometric absorption that the electrons were separated latitudinally on the basis of various energies; the low-energy electrons were pulled further toward the North than the high-energy ones. (TTT)

11252 SPORADIC CYCLIC VARIATIONS OF THE INTENSITY OF COSMIC RAYS AND THE SOLAR ACTIVITY. Bazilevskaya, G. A.; Charakhch'yan, T. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1807-9(Nov. 1966). (In Russian).

In view of earlier findings, according to which the cosmic-ray intensity changes with a period of 20 to 23 days, it was attempted to correlate these changes with the solar activity. Diurnal data on the intensity of the ionizing component of cosmic rays in the stratosphere over Murmansk, Moscow, Simeiz, and Alma-Ata were examined, comparing them with reported values of the intensity of the neutron component at the Deep River Station; the author's previously reported method was used to determine the course of secular variations and deviations from the anticipated behavior. Cyclic variations with periods ranging from 16 to 30 days were found in the six-month-long measurements. The cyclic variations observed in the stratosphere agree with the neutron monitoring data. The sunspot values also exhibited a 16- to 30-day periodicity but no close correlation could be established between the solar activity and cosmic radiation. This behavior could be explained by assuming that the active regions move at a rate of 5° per day on the surface of the Sun but this could not be confirmed by astronomical observations. Quite probably, this phenomenon is due to pulsations of the solar activity caused by temporary changes of the properties of the interplanetary space, such as magnetic inhomogeneities, which affect the propagation of cosmic rays. (TTT)

11253 STUDY OF ENERGY SPECTRUM VARIATIONS OF THE PRIMARY COMPONENT OF COSMIC RAYS ON THE BASIS OF STRATOSPHERIC DATA. Stozhkov, Yu. I.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1810-12 (Nov. 1966). (In Russian).

The energy spectrum of the secular variations in the intensity of cosmic rays in space is usually studied by means of their altitude dependence in the atmosphere at various geomagnetic latitudes. From the relative increase of the number of particles as a function of pressure, the energy spectrum of the variation of the primary component may be determined if the necessary correlation coefficient is known; in the study for the region over Murmansk, these values were not available for primary particles with energies higher than 17 BeV. Using the altitude-dependence data collected during the period from 1959 to 1964 in the stratosphere at various geomagnetic latitudes, the corresponding secular variation of the energy spectrum was directly determined. The values obtained were found to be comparable with those derived from E. N. Parker's theory, assuming that the mean free path of scattering of particles on magnetic inhomogeneities of the solar wind is dependent on the hardness of the particles, within the 1- to 15-BeV range. (TTT)

11254 COSMIC-RAY INDUCED NEUTRON EMISSION OF THE MOON. Zakharchenko, V. F. (Inst. of Geophysics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1813-14(Nov. 1966). (In Russian).

Passage of the nuclear-active components of cosmic rays terminates in a low-energy nuclear disintegration, the product of which contain neutrons with energies of several MeV. Interaction of these neutrons with matter, follows a Boltzmann-type equation. The neutrons from an isotropic and monochromatic source leaving a medium through a plane surface bounded by a vacuum may be determined by means of an expression including an exponential integral function and a term indicating the total microscopic cross section of interaction of the neutrons with matter; the expression also allows the intensity of thermalization to be determined. In order to estimate the neutron emission of the Moon, the results obtained in the terrestrial atmosphere must be generalized, even though the physical conditions are different. The calculations yielded values of 0.2 cm^{-2} sec^{-1} for the primary neutron flux and 1 cm^{-2} sec^{-1} for the integral flux from 1 eV to 1 MeV. For the calculations it was assumed that the Moon's surface layer consists of quartz with a density of 0.5 g cm^{-3}. The neutron intensity at the surface yields valuable information concerning the chemical composition of the medium. (TTT)

11255 CONSIDERATION OF THE CURRENTS IN THE AKASOFU–CHAPMAN MODEL RADIATION BELTS ON THE CUTOFF RIGIDITY OF COSMIC RAYS. Dorman, L. I.; Tyasto, M. I.; Fedorova, Z. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1830-2(Nov. 1966). (In Russian).

Attempts were made to estimate changes in the cosmic-ray cutoff rigidity caused by currents which arise from the motion of trapped radiation particles, as postulated by the Akasofu–Chapman model radiation belt. Calculations based on assumed values of a distance from the center of the earth to an arbitrary point, the latitudinal angle, the geomagnetic longitude relating to the area covered by the current, and on the distance on the center to the point at which the dipole line of force intersects the equatorial plane of the dipole, made it possible to derive the vector integral of the magnetic field of the current. The calculated perturbed cutoff rigidity values were compared with experimental data. The results contradicted the expected experimental values concerning the increase of the minimum of the Forbush effects. It was concluded therefore that the current indicated by the Akasofu–Chapman model does not satisfy the observed variations of the cutoff rigidity observed on the Earth. (TTT)

11256 CORRELATION BETWEEN THE CUTOFF RIGIDITY OF COSMIC RAYS AND MACILWAIN L PARAMETER. Dorman, L. I.; Smirnov, V. S. (Polar Geophysics Inst., Academy of Sciences, USSR. Inst of Geomagnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1835-6(Nov. 1966). (In Russian).

Cosmic-ray studies by satellites revealed that the L coordinate is an excellent parameter for investigating the intensity of trapped radiation and of cosmic rays; there is thus a correlation between the cutoff rigidity of cosmic rays and the L coordinate. The problem was more closely examined, checking data collected on the surface of the Earth and at various altitudes. Their asymmetry of the geomagnetic field was neglected. From the formulas derived on the basis of the magnetic field values and the vector potential, using Taylor series, an expression was obtained for determining these correlations; however, the expression was not suitable for practical computation. For this reason the magnetic moment for the higher harmonics of the geomagnetic fields were expressed by means of nondipole portion of the field at the equator and at the latitude of observation. Good agreement was found between the theoretical and experimental values. (TTT)

11257 CALCULATION OF THE ASYMPTOTIC DIRECTIONS OF COSMIC RAYS FOR THE SOVIET COSMIC-RAY STATIONS.

Dorman, L. I.; Smirnov, V. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1837-8(Nov. 1966). (In Russian).

It has been found recently that there is a marked difference between the asymptotic directions of cosmic rays in real and dipole geomagnetic fields, amounting up to and above 40° at low energies. In order to calculate this effect, the asymptotic directions of cosmic rays must be recalculated, taking into account the higher harmonics of the Earth's magnetic field. In order to determine these asymptotic directions for the 13 Soviet stations, 5000 cosmic-ray trajectories in the magnetic field of the Earth were computed. A formula was derived for determining the position of the source with the highest possible precision. In the calculation of the trajectories of particles arriving under a given angle of incidence, care was taken to ensure that the zenithal and aximuthal angles were so chosen that the contribution of particles arriving from various angles within a certain given range were kept constant; however, the needed correlation coefficients were not available. Therefore, in order to make comparison of asymptotic directions in the real field with data obtained in the geometric dipole field, the calculations were standardized to incident particles arriving under 16° and 32° South, East, North, and West. For some of the stations the calculations included also data concerning the zenithal angle of 48°. (TTT)

11258 PROPERTIES OF THE INTERPLANETARY SPACE, DETERMINED FROM THE 11-YEAR VARIATIONS OF HIGH- AND LOW-ENERGY COSMIC RAYS. Dorman, I. V.; Dorman, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1839-42(Nov. 1966). (In Russian).

Comparison of the proton and α-particle spectra measured by means of the IMP-1 satellite with earlier data indicated that during the period from June 1963 to the beginning of 1964, the intensity gradient of cosmic rays in the interplanetary space and in the stratosphere decreased by a factor of 4 to 5. A corresponding decrease of the depth of modulation was noted especially at low rigidities. Changes of the electromagnetic conditions in the interplanetary space were used therefore, to estimate corresponding changes of the solar activity. Tabulation of the data reported by various authors indicated that the effective values of the duty factors and the dimensions of the inhomogeneities change with variations of the solar activity. (TTT)

11259 CORRELATION BETWEEN THE TYPE-IV RADIO-BURSTS AND THE DIURNAL SOLAR VARIATION OF COSMIC RAYS, AND THE RATIO OF THE FIRST AND SECOND HARMONICS DERIVED FROM DATA COLLECTED DURING THE INTERNATIONAL GEOPHYSICAL YEAR. Stepanyan, A. A.; Vladimirskii, B. M.; Pankratov, A. K. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1843-5(Nov. 1966). (In Russian).

No definite correlation has been yet established between the diurnal solar variation and the solar activity. There are reports that the amplitude of the diurnal variations corresponds to type-IV radio bursts. In order to clarify the problem, the time dependence of the first and second harmonics of the diurnal variation after type-IV radio bursts was examined, using neutron-monitor data from 6 longitudinally equidistant stations. It was found that in the average, the amplitude of the first harmonic increases only slightly ($0.05 \pm 0.02\%$), as observed 3 days after the burst; however, it is possible that this varies strongly in individual cases. The bursts were therefore subdivided into special groups depending on the character of the magnetic storm. The ratio of the second and first harmonics was found to be ~0.20 from neutron-monitor data at medium latitudes; earlier calculations of the author indicated that it should be ~2.5 times higher, or 0.5. (TTT)

11260 SUDDEN VARIATIONS IN THE INTENSITY OF COSMIC RAYS. Alaniya, M. V.; Dorman, L. I.; Shatashvili, L. Kh. (Inst. of Geophysics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1849-50(Nov. 1966). (In Russian).

The variations of the seasonal diurnal frequency distribution of the sudden intensity changes of the neutron component of cosmic rays were investigated, attempting to determine their correlation with solar activity. Neutron intensity data from the climax, Norikura, and Dallas Stations were analyzed. The study revealed that the seasonal diurnal distribution of the sudden increases of the neutron component intensity depends on changes of the solar activity although the correlation is not very pronounced. The number of the sudden activity changes decreases strongly near the minimum of the solar activity (1964), rendering difficult the analysis during that period. This phenomenon was also observed during 1954–55 at the Climax Station. (TTT)

11261 DIURNAL MESON INTENSITY WAVE ORIGINATED IN THE ATMOSPHERE AT HIGH LATITUDES. Fedchenko, K. K. (Polar Geophysics Inst., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1846-8(Nov. 1966). (In Russian).

The atmospheric temperature affects strongly the daily variations of the hard component of cosmic rays. In view of the fact that earlier investigations have been carried out at medium and low latitudes only, the problem was studied on the basis of high-latitude observations. The temperature variations were determined by probes launched simultaneously from stations at various longitudes using observations of aerological stations at the latitudinal belt of $73 \pm 5°$. At each station, the seasonal temperature differences were determined at various isobaric levels, from the Earth's surface to 50 mbar. The daily variations of the meson intensity, $\delta I/I$ at high latitudes were calculated by the Dorman–Feinberg formula. It was found that during every season, except fall, the phase of daily variations of the temperature-induced wave is the same at high latitudes as at intermediate latitudes but their amplitude is much smaller. The fall data must be further examined. (TTT)

11262 SOLAR-DIURNAL VARIATIONS OF THE INTENSITY OF THE NEUTRON COMPONENT OF COSMIC RAYS IN ANTARCTICA DURING 1963–1964. Dorman, L. I.; Fisher, S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1851-6(Nov. 1966). (In Russian).

Following up the analysis of unusual phase changes of diurnal solar variations observed during the 1954 minimum of solar activity, a similar study was undertaken for the 1963–64 period of the quiet Sun. The results of the harmonic analysis of the average monthly intensity values of the neutron component from the Vostok, Wielkes and Mauson Stations indicated that even though the amplitude varied several fold, the phase changes were quite small. Data from various other stations were also analyzed for determining the exponent β of the rigidity spectrum. It was found desirable to use for this purpose data from stations with different cutoff rigidities and located at different geomagnetic latitudes. The correlation between the variations of β and of the cutoff rigidity of the stations showed that the diurnal variation spectrum is more complex than it has been assumed by McCraken et al. in the IQSY Instruction manual. (TTT)

11263 THE SEPTEMBER–OCTOBER, 1962 FORBUSH EFFECT. Blokh, Ya. L.; Dorman, L. I.; Kaminer, N. S.; Kuz'micheva, A. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1861-3(Nov. 1966). (In Russian).

The measurements obtained by means of Mariner II from Sept. 2 to Oct. 16, 1962 concerning the plasma velocity and the magnetic field in space, yielded useful data to estimate the width of solar corpuscular streams and the characteristics of their magnetic field. This study was extended by attempting to determine the parameters of corpuscular streams from the variations of cosmic rays at the surface of the Earth during magnetic storms, using the authors' earlier method. This involved examination of the Forbush effect in cosmic rays on the Earth during the period from Sept. 30 to Oct. 5, 1962, exhibiting an ~2.5 to 3% amplitude in the neutron component; the solar activity was low during this time. Comparison of the parameters of the solar corpuscular stream from the Mariner-II data with the values obtained from the analysis of cosmic ray variations exhibited a satisfactory agreement. It may be therefore concluded that the calculation method used may be applied to determine the corpuscular streams and their magnetic field characteristics which create the Forbush effect, yielding information about the state of the interplanetary space during periods of magnetic storms. (TTT)

11264 ANISOTROPY OF THE 10^{10}- TO 10^{12}-eV COSMIC RAYS IN THE GALACTIC SPACE. Dorman, L. I.; Inozemtseva, O. I.; Ilgach, S. F.; Mazaryuk, E. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1857-60(Nov. 1966). (In Russian).

Neutron-monitor data from 12 stations of the worldwide network were used to study the sidereal–diurnal variation of cosmic rays during 1960–1965. From the analysis of the first harmonics of the variations and the latitude dependence of the amplitude, it was concluded that a substantial portion of the observed sidereal wave is due to spurious effects arising from the modulation of solar–diurnal variations. These spurious effects in the neutron component are due in part to the modulation of the atmospheric temperature and in part to geometric effects arising from the inclination of the Earth's axis of rotation. The maximum of the latitude dependence is probably located at intermediate latitudes and the phase probably changes its sign when passing from the Northern to the Southern hemisphere. It was concluded that the observed sidereal variations are due to secondary effects. (TTT)

11265 HOW IS THE ENERGY OF THE ELECTRON COMPONENT OF COSMIC RAYS REMOVED? Rozental', I. L. (Moscow Engineering Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fix., 30: 1784-5(Nov. 1966). (In Russian).

The equation describing the energy change of the electron en-

ergy as a function of time contains terms accounting for losses due to ionization, bremsstrahlung, magnetic and inverse Compton effect. The relative loss distribution depends strongly on the photon density ω_γ. It was concluded that if in an uninvestigated wave length range $\omega_\gamma \geq 1$ eV cm^{-3}, then, in the Galaxy, the inverse-Compton-effect-type energy losses will predominate; in the Metagalaxy, where the number of particles is much smaller than in the Galaxy and $\omega_\gamma \approx 1$ eV cm^{-3}, the Compton-effect-type losses prevail. The concrete form of the energy transfer spent by the electron for ionization was examined earlier by the author. Ultimately, all of the energy of the fast electrons is used up in the formation of slow δ electrons, the energy of which is used up to excite hydrogen atoms; when the latter passes to the ground level, they emit ultraviolet radiation. Lower-energy δ electrons may also play the role of an intermediate agent in the formation of relatively low-energy photons, and especially of galactic x rays; the δ mechanism may be also responsible for the creation of low-energy electrons. In order to confirm this assumption, the sign of the electron charge must be measured. (TTT)

11266 MOTION OF COSMIC PARTICLES IN A RANDOM MAGNETIC FIELD. Dolginov, A. Z.; Toptygin, I. N. (Ioffe Inst. of Physics and Tech., Leningrad. Leningrad Polytechnic Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1780-3(Nov. 1966). (In Russian).

The motion of cosmic particles in the interstellar and interplanetary medium is determined primarily by their scattering on the magnetic fields of space, transported by plasma clouds. Such a scattering on these moving inhomogeneities of magnetic fields changes the energy spectrum and the direction of motion of the particles. In view of the fact that the normally employed diffusion approximation often does not apply for real cases, it was attempted to solve this problem by using the Boltzmann equation for noninteracting particles moving in an external magnetic field. The derived equations were averaged out for any possible value of the magnetic field, introducing also a second-order correlation tensor to indicate the complete characteristics of the random field. If the diffusion occurs in a space without moving regions with a strong magnetic field, which allow only a slight penetration of the particles, exact solutions are obtained in the form of degenerate hypergeometric functions. In order to obtain reliable data, the energy dependence of the diffusion coefficient must be taken into account. (TTT)

11267 FORMATION OF HELIUM ISOTOPES IN COSMIC RAYS. Zhadanov, A. P.; Kuz'min, V. N.; Yakovlev, R. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1778-9(Nov. 1966). (In Russian).

It has been assumed that in cosmic radiation sources heavy nuclei are preferentially accelerated; when these nuclei pass through interstellar gas, they interact with hydrogen and helium nuclei, yielding a cosmic ray composition observed on the Earth. It was attempted to confirm this theory by studying the formation of helium isotopes during the fragmentation of light nuclei in an accelerator, irradiating lithium, beryllium, carbon, oxygen and ^{4}He targets with 660-MeV protons. The spectra of the particles with a double charge were measured by means of a low-sensitivity nuclear emulsion. Examination of the energy and angular distribution of the ^{3}He yield revealed that this isotope is formed mostly by the direct interaction of protons with the α substructures of light nuclei. The yields of these fragmentation tests agree with data on the helium nuclei content in primary cosmic radiation. If it is assumed that the path of the nuclear component of the cosmic radiation, which is fragmented into lighter components when passing through the interstellar gas, amounts to 2 to 3 free paths of interaction, it is found that the ^{3}He content in cosmic rays near the Earth amounts to 26 to 27%. (TTT)

11268 MODULATION OF THE GALACTIC COSMIC RAYS IN THE INTERPLANETARY SPACE. Charakhch'yan, A. N.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1738-46(Nov. 1966). (In Russian).

It has been found that the intensity changes of cosmic radiation in space coincide very closely with variations of solar phenomena. Quasi-cyclic phenomena with periods between 14 and 30 days, e.g., intensity changes obtained at Deep River and the number of sunspots, show identical behavior. Examination of results of a six-year-long series of measurements in the stratosphere and theoretical calculations yielded a new space–time relationship in the secular modulation of galactic cosmic rays in the interplanetary space. The radius r of the sphere, within which the galactic cosmic rays are modulated under the influence of the solar wind, depends on the solar activity; in 1962 r was about 7 AU and in 1958 it was about 9 AU. The total intensity of galactic cosmic rays of the Earth at the end of 1964 was 90 to 95% of the intensity of the cosmic radiation emitted by the Galaxy. (TTT)

11269 VARIATIONS OF COSMIC RAYS, THEIR CLASSIFICATION AND ORIGIN. I. A CRITICAL EXAMINATION OF THE CURRENT CLASSIFICATION OF THE VARIATION OF COSMIC RAYS. Dorman, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1722-37(Nov. 1966). (In Russian).

The expression, derived previously by the author, for classifying the intensity changes of cosmic rays includes a term corresponding to cosmic radiation which originates in the atmosphere and may be attributed to either temperature or barometric effects. The second term relates to geomagnetic variations while the third term takes into account the extraterrestrial intensity changes. The third group is further subdivided into changes due to effects generated by the Sun, to modulations in the interplanetary space and to galactic and extragalactic variations. As a result of the large scale cosmic ray research efforts throughout the world since the last International Geophysical Year by means of rockets and satellites and the data obtained in the global network of research stations, data have been accumulated which cannot be fitted into the previously derived expressions. The new formulas take into account the behavior of galactic and solar cosmic radiation in space by means of the anisotropic diffusion approximation indicated the determination of the diffusion tensor and the drift rate in the interplanetary space. The effect of the solar activity is also taken into account. (TTT)

11270 PRELIMINARY RESULTS OF A STUDY OF THE DISTRIBUTION OF COSMIC RAYS IN THE EASTERN PART OF THE USSR. Granitskii, L. V.; Dorman, L. I.; Kovalenko, V. A.; Mad'yarov, R. Z.; Gushchina, R. T.; Davydov, A. E.; Dorman, I. V.; Milovidova, N. P.; Khachikyan, V. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Novosibirsk, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1393-4(1967). (In Russian).

Neutron monitor and semicubical telescope measurements of the intensity of the cosmic-ray neutron component and radiosonde measurements of the intensity of the total ionizing component in the stratosphere were recorded at a number of sites with cutoff rigidities ranging from 0.3 to 7.5 BV during the August to October 1966 expedition of the Siberian Institute of Terrestrial Magnetism, the Ionosphere, and Radiowave Propagation from Ust'-Kut to Vladivostok via Tixie Bay, Pevek, Provideniye Bay, and Port Vanino. Preliminary results corrected for the temperature and pressure effects but not for temporary intensity changes (Forbush decreases), are presented graphically and are compared with similar data recorded during 1965. Although the solar activity increased considerably during the year that elapsed between the two series of measurements, there was no significant change in the cosmic-ray intensity. This is ascribed to delay in the response of the cosmic-ray intensity to changes in solar activity. (ATD)

11271 SECULAR MODULATION OF THE COSMIC RAY INTENSITY IN INTERPLANETARY SPACE. Charakhch'yan, A. N.; Charakhch'yan, T. N. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1313-18(1967). (In Russian).

The authors took advantage of several instances in 1960, 1961, 1963, and 1964, when the solar activity as measured by sunspot numbers decreased suddenly (over a period of a few days) and remained constant thereafter for some months at a new and lower level, to investigate the transient behavior of the modulation of cosmic-ray intensity in interplanetary space. The cosmic-ray intensities employed in this study were recorded in the stratosphere above Olen' (near Murmansk) and Mirnyi. It was found that after such a decrease in solar activity the cosmic-ray intensity increased for a month or two and the new steady value was asymptotically approached with a half-time that increased with decreasing solar activity, being 10 to 15 days in 1961, 20 to 30 days in 1963, and 40 to 50 days in 1964. From this it is concluded that the velocity of the magnetic clouds in interplanetary space decreases with decreasing solar activity. The short duration of these transients is difficult to reconcile with the long (6 months to a year) hysteresis effect in the cosmic-ray intensity at the beginning of a new 11-year solar activity cycle. It is suggested that the velocity of the magnetic clouds ejected in the first months of a new solar activity cycle may be lower than the velocity of the clouds ejected during the last months of the old cycle. The relative change in the cosmic-ray intensity as measured at different atmospheric depths decreased considerably with increasing atmospheric depth when the intensity change took place during the phase of decreasing solar activity, but it was almost independent of atmospheric depth when the intensity change took place at the beginning of the new solar activity cycle. There were times when the cosmic-ray intensities above Olen' and Mirnyi were different, indicating anisotropy of the cosmic radiation in the vicinity of the Earth. The anisotropy sometimes amounted to 5% and persisted for about a month. (ATD)

11272 NEUTRON COMPONENT OF COSMIC RAYS AT ATMOSPHERIC DEPTHS OF 260 TO 315 MILLIBARS. Granitskii, L. V.; Dorman, L. I.; Bortnik, S. G.; Novikova, G. A.; Raikhbaum, I. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1322-3(1967). (In Russian).

Ground level measurements in 1965 with a new neutron monitor gave practically the same results as a standard monitor of the Moscow State University type and the Canadian expeditionary supermonitor for the latitude dependence and coupling coefficients of the neutron component. In the present paper there are presented graphically the results of measurements with the new instrument at sea level and at atmospheric depths of 260 and 350 millibars during January and February 1966 at stations with geomagnetic cutoff rigidities ranging from about 0.5 to 8 BV. The following quantities are plotted against geomagnetic cutoff rigidity; the intensity of the neutron component at each level, normalized separately for each of the three levels to unity for a station where the geomagnetic cutoff rigidity is 1 BV; the coupling coefficient for the neutron component for each of the three levels; and the pressure coefficient for the neutron component for the 260- to 315-millibar pressure interval. (ATD)

11273 VARIATIONS OF HIGH-ENERGY COSMIC RAYS. Kuz'min, A. I. (Inst. of Space Physics Research and Aeronomy, Yakutsk, USSR.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1372-80(1967). (In Russian).

This paper is devoted largely to a discussion of the solar–diurnal cosmic-ray intensity variation as revealed by the intensities of the muon component recorded at ground level and at depths of 7, 20, and 60 mwe underground at Yakutsk during the period from 1958 through 1965. Other cosmic-ray intensity variations and neutron-component intensity measurements are discussed briefly. The first and second harmonics of the solar–diurnal variation of the cosmic-ray neutron intensity at ground level and the muon intensity at ground level and at different depths were evaluated. The amplitude of the diurnal variation of the neutron intensity changed very little during the investigated period, but the amplitude of the muon intensity variation decreased sharply in 1960. The energy spectrum of the first harmonic of the diurnal variation, derived from the depth dependence of the amplitude of the muon component, is represented by an expression of the form $(6 \times 10^{-3})b/(b + E)$, with values of 59, 39, and 30 BeV for the parameter b for periods of high, moderate, and low solar activity, respectively. The amplitude of the second harmonic was very small, and its energy spectrum could not be determined. Forbush decreases were more frequent and deeper, and recovery from them was more rapid in periods of high solar activity than in periods of low activity. The 27-day variations had a softer energy spectrum in 1962–1965 than in 1957–1959. The data recorded underground at Yakutsk did not reveal the secular variation, although there was an appreciable secular effect in the ground level data (amounting to about 20% for the neutron component, and 4% for the muon component). It is concluded that the energy spectrum of the secular variation is considerably softer than that of the Forbush decreases, the 27-day variations, or the diurnal variations. The above findings are discussed and it is concluded that a decrease in the velocity of the solar wind from 500 to 600 km/sec in a period of maximum solar activity to 250 to 300 km/sec in a period of minimum activity would be sufficient to explain them. (ATD)

11274 INTENSITIES OF PRIMARY AND SECONDARY COMPONENTS OF COSMIC RAYS IN THE STRATOSPHERE. Charakhch'yan, A. N.; Charakhch'yan, T. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1247-9(1967). (In Russian).

Intensities of primary and secondary cosmic-ray components in the stratosphere are reported. Data concerning the total intensity of cosmic rays for a pressure of $x < 100$ gr $\cdot$ cm^{-2}, obtained by regular measurements using RK-1 radiosondes at Murmansk (0.5 BV), Leningrad (1.5 BV), Moscow (2.3 BV), Simferopol' (5.7 BV), and Alma-Ata (6.6 BV), are shown. The curve for 14.6 BV was plotted on the basis of measurements obtained in the Antarctic; it shows that cosmic-ray intensity extrapolated toward the edge of the atmosphere near the equator is 700 m^{-2} $\cdot$ sec^{-1} $\cdot$ ster^{-1}, which exceeds the intensity of the primary component at this latitude by approximately 10 times. Measurement results for absolute intensity of primary cosmic rays are shown. The work provides data concerning the intensity of albedo particles. It is shown that albedo particle flux is 600 at the equator and 1500 m^2 $\cdot$ sec^{-1} $\cdot$ ster^{-1} at Murmansk, i.e., there is a difference of 2.5 times. The energy flux of the primary cosmic rays differ approximately proportionally at those latitudes. At the equator, the energy flux of primary cosmic rays is $3.6 \cdot 10^3$ BeV $\cdot$ m^2 $\cdot$ sec^{-1} $\cdot$ ster^{-1} while at Murmansk it is 10^4 BeV $\cdot$ m^2 $\cdot$ sec^{-1} $\cdot$ ster^{-1}. It is supposed that the albedo particles are basically electrons developed as a result of electromagnetic successive processes in the atmosphere, and that their number is proportional to the energy flux of primary cosmic rays. (ATD)

11275 MOTION OF COSMIC PARTICLES IN THE MAGNETIC FIELDS IN INTERPLANETARY SPACE. Dolginov, A. Z.; Toptygin, I. N. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1269-72(1967). (In Russian).

The motion of charged cosmic-ray particles in the magnetic field in interplanetary space, which has both randomly fluctuating and regular components, is discussed. The discussion is based on the kinetic equation introduced in an earlier paper by the authors (Izv. Akad. Nauk SSSR. Ser. fiz., 30: 1780(1966)) and the diffusion equation to which it leads, which is an improvement on the diffusion equation of E. N. Parker (Phys. Rev., 110: 1445(1958)) as regards treatment of the effects of the moving magnetized plasma clouds. It is shown that when the diffusion approximation is valid and the regular component of the magnetic field vanishes, the fluctuations in the solar-wind velocity have little effect on the particle density N, which, in the ultrarelativistic case with a $dE/E^{2.5}$ energy spectrum, is proportional to $p^{-4.5}$, where p is the particle momentum. When the regular component of the magnetic field does not vanish and the fields of the magnetized clouds are weak, the particles move mainly along magnetic lines of force and the guiding center model is to be preferred to the diffusion model. In this case lower-energy cosmic-ray particles may penetrate more easily into the solar system than higher-energy ones. When there are small inhomogeneities acting as fixed scattering centers in the presence of a strong regular background field, the motion of the particles is described by the drift equation of V. D. Sivukhin (Voprosy teorii plazmy, Vol. 1, Gosatomizdat, Moscow, (1963)) supplemented with collision terms. It is suggested that this equation describes the motion at distances of several astronomical units from the Sun. (ATD)

11276 MEASUREMENT OF SOLAR PROTONS IN THE 1 TO 5 MeV RANGE BY ZOND-3, VENERA-2, AND VENERA-3. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Logachev, Yu. I.; Lyubimov, G. P.; Nikolaev, A. G.; Pereslegina, N. V. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1296-9(1967). (In Russian).

Simultaneous recordings of low-energy proton flux by the Venera-2, Venera-3, and Zond-3 spacecraft are briefly discussed. The detectors used were surface-barrier semiconductor types with an area of 0.2 cm^2, a junction thickness of 35 microns, and were designed to register protons in the 1 to 5-MeV range. The detector window axes were oriented approximately 90° from the Sun line. On six occasions in 1965–66, above-normal proton flux was recorded by the three craft, some examples of which are shown. Assuming the flux increase to be caused by solar events observed at the time, and also assuming that the protons followed a spiral path in the magnetic field, the authors calculated radial plasma velocities ranging from 220 to 900 km/sec. They note, however, that their assumptions on the radial paths of the solar protons are idealized, and may be incorrect. The experiments did verify a higher incidence of 1 to 5-MeV protons than was previously suspected, relative to that of higher-energy protons. They also showed that the propagation processes in space of the low- and high-energy protons are substantially different. (ATD)

11277 TWENTY-SEVEN DAY COSMIC-RAY INTENSITY VARIATIONS AND STRUCTURE OF THE SOLAR CORPUSCULAR STREAMS. Dorman, L. I.; Luzov, A. A.; Krutsselevskaya, G. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1287-9(1967). (In Russian).

The relation between the 27-day cosmic-ray intensity variations and solar activity is discussed on the assumption that the cosmic-ray variations are due to corpuscular streams emitted radially by the Sun. In view of the fact that solar activity is confined mainly to two heliographic latitude regions symmetric with respect to the solar equator, there should be an annual wave in the amplitude of the 27-day variations; it is shown that there is indeed such an annual wave, and that it correlates closely with the annual wave in the neutron component intensity. The variations from August 1957 through November 1958 in the total sunspot areas in the northern and southern solar hemispheres are compared with the corresponding variations of the cosmic-ray neutron intensity. It is shown that the cosmic-ray intensity correlated negatively with the sunspot area. The correlation between the cosmic-ray intensity and the sunspot area in the northern solar hemisphere was strong during the second halves of 1957 and 1958 and was weak during the first half of 1958, and the corresponding correlation for the southern hemisphere was strong during the first half of 1958 and was weak during the second halves of 1957 and 1958. It is concluded that the recurrent cosmic-ray phenomena reflect the combined effects of several plasma streams from the Sun, and that

these plasma streams originate in both solar hemispheres and flow very nearly radially. (ATD)

11278 SPORADIC CYCLIC COSMIC-RAY INTENSITY VARIATIONS. Bazilevskaya, G. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1284-6(1967). (In Russian).

This paper represents a continuation of earlier work of the author and T. N. Charakhch'yan (Izv. Akad. Nauk SSSR. Ser. fiz., 29: 1888(1965); ibid. 30: 1807(1966)) on sporadic world-wide cyclic cosmic-ray intensity variations with periods between 16 and 34 days. Four such variations with periods between 19 and 24 days, durations of several months each, and amplitudes between 1 and 3% at Moscow, that were observed between 1958 and 1962 in the cosmic-ray intensity in the stratosphere above Murmansk, Moscow, and Simenz and in the neutron-monitor data from Deep River, Mt. Norikura, and Huancayo, are discussed. The ratios of the amplitudes of these variations at the different stations were approximately equal to the corresponding ratios of the amplitudes of Forbush decreases at the same stations; from this it is concluded that the rigidity spectrum of the variations is approximately the same as that of Forbush decreases. The deviations of the cosmic-ray intensity from the secular trend were correlated with the corresponding deviations of the Wolf sunspot number and the 2.8 kMHz radio-noise level, the greatest correlation coefficient of about 0.65 being found when the cosmic-ray data were delayed by 40 to 70 days with respect to the solar-activity data. The amplitudes of the cosmic-ray variations were proportional to those of the corresponding sunspot number variations. It is concluded that the sporadic cyclic cosmic-ray intensity variations are due to modulation of the cosmic-ray intensity by corresponding sporadic cyclic variations of the solar activity. If the velocity of the solar wind is 500 km/sec, the modulation must take place within a distance of about 20 astronomical units of the Sun. (ATD)

11279 TWENTY-SEVEN DAY COSMIC-RAY VARIATIONS. Filippov, V. A.; Krymskii, G. F.; Kuz'min, A. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1281-3(1967). (In Russian).

The 27-day variations of the cosmic-ray muon component at sea level and at different depths underground, recorded at Yakutsk during the 1963–1965 period of low solar activity, were compared with corresponding data recorded during the 1957–1959 period of high solar activity. When the data were corrected for the temperature effect as well as for the pressure effect, it was found that the amplitude of the 27-day variation was very low during the period of solar activity and was quite appreciable during the period of high solar activity. It is concluded that the amplitude of the 27-day variation decreases with decreasing solar activity. The diffusion constant for cosmic-ray particles in the vicinity of the Earth's orbit was calculated from these data on the assumption that azimuthal asymmetry of the solar wind is responsible for the 27-day variation, the velocity of the solar wind is 300 to 400 km/sec, and the diffusion constant is proportional to the distance from the Sun. It is concluded that the transport free path for 10 to 15-BeV particles in the vicinity of the Earth's orbit is about 4×10^{12} cm in a period of high solar activity, and greater than 2×10^{13} cm in a period of low solar activity. If this conclusion is correct, the diffusion approximation would not be adequate for the description of the motion of cosmic-ray particles within the solar system during a period of low solar activity. (ATD)

11280 11-YEAR VARIATION OF COSMIC-RAY INTENSITY BEYOND THE EARTH'S MAGNETOSPHERE. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Logachev, Yu. I.; Lyubimov, G. P.; Pereslegina, N. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1255-8(1967). (In Russian).

Measurements of the cosmic-ray intensity beyond the Earth's radiation belts and magnetosphere have been made, beginning with the first Soviet space rocket (LUNA-1). These measurements have made it possible to trace the dependence of primary cosmic radiation on solar activity almost from its maximum (January 1959) to its minimum (1965–1966). Intensities of cosmic-ray fluxes measured by all the spacecraft launched by the USSR and sent beyond the radiation belts are presented. Cosmic-ray intensity was recorded by STS-5 and SBM-10 counters. Effective areas of the STS-5 counters (1 cm in diameter, 5 cm in length) varied within 10%, and for the SBM-10 counters (0.6 cm in diameter, 1 cm in length) variations were within 20%. The spread of the measured intensities is attributed not only to different geometrical factors but also to different multiplication of the primary cosmic radiation in the medium surrounding a counter. (ATD)

11281 IONIZATION CHAMBER STUDIES OF COSMIC RAYS WITH THE KOSMOS-19 AND KOSMOS-25 SATELLITES. Kuzhevskii, B. M.; Shafer, Yu. G. (Inst. of Space Physics Research and Aeronomy, Yakutsh, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1252-4(1967). (In Russian).

The Kosmos 19 and Kosmos 25 satellites carried counter-controlled ionization chambers with geometric factors of 1500 cm^2/sterad, which recorded the total ionization produced by passage of a fixed number (256) of cosmic-ray particles. The ionization per particle recorded with these ionization chambers exhibited changes (both increases and decreases were observed) which took place within periods of a few days, were at least sometimes associated with solar flares, and were accompanied by either like or opposite changes in the cosmic-ray intensity (total particle flux). In at least one case the change in the ionization per particle amounted to 15%. The simultaneous changes in opposite senses of the ionization per particle and the cosmic-ray intensity are ascribed to changes in the proton flux, and the changes in the same sense, to changes in the nuclear component flux. The latter interpretation is supported by a comparison of Kosmos 25 ionization chamber data with nuclear component fluxes recorded with a Cherenkov counter carried by the Elektron 4 satellite. It is concluded that at times of solar flares there arrives in middle latitudes an additional stream of particles with lower energies than are allowed by the geomagnetic thresholds, and there also arrive additional streams of heavier nuclei. (ATD)

11282 ENERGY SPECTRA OF VARIOUS-Z NUCLEI AS MEASURED BY THE PROTON-1 AND PROTON-2 SATELLITES. Volodichev, N. N.; Grigorov, N. L.; Savenko, I. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1231-2(1967). (In Russian).

Satellites Proton-1 and Proton-2 carried mass spectrometers to determine the charge spectra of atomic nuclei registered in orbit, particularly the extra-heavy nuclei ($Z > 40$). The SEZ-1 Cherenkov counter was designed for this purpose and can register Z from 1 to 50. The count levels registered by both satellites for 4 charge ranges are shown. The difference in count totals for a given Z level is explained by the different tumbling modes of the two satellites; however, as expected, the ratios of heavy to light nuclei were essentially the same in both cases. The mean value for $N(Z \geq 42)/N(Z \geq 21)$ was 0.015, and for $N(Z \geq 48)/N(Z \geq 21)$ it was 0.004. The Z-spectrum was further broken down by geographical latitudes. Such data from 25 Proton-2 orbits are shown. From the ratio figures it is seen that within the observed Z range, the spectral characteristic for heavy nuclei is nearly the same as for helium nuclei. Uncertainty factors in recorded data were due to the limited resolving power of the counter and to the possible variation in threshold levels by ±10%. (ATD)

11283 CHEMICAL CONSTITUENTS OF PRIMARY COSMIC RAYS WITHIN THE ENERGY RANGES MEASURED BY PROTON-1 AND PROTON-2. Volodichev, N. N.; Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1229-30(1967). (In Russian).

This supplements a companion article by the same authors on spectral data obtained from the SEZ series Cherenkov counters carried on the Proton-1 and -2 satellites. The counter was a nine-stage device which permitted registration of the charge and energy level of particles up to $Z = 48$ and 15 BeV, respectively. Some graphical results are presented in the form of Z ratios (referred to helium) vs. energy level, for Proton-1 orbits 199 to 207 and Proton-2 orbits 105 to 113. In all cases, within measurement accuracy, the count rate of particles of a given Z did not appear to be a function of their incident energy. Variations in particle count because of vehicle tumbling were also recorded. The angle between counter vertical axis and the zenith for the 45th to 52nd orbits of Proton-2 is given. The ratio figures show no significant changes as functions of zenith angle. Summary data registered for a 775-minute total recording time gave the following nuclei figures: 74,200 helium; 2790 with $3 \leq Z \leq 5$, 5800 with $6 \leq Z \leq 9$, 2100 with $Z \geq 10$, and 474 with $Z \geq 20$. (ATD)

11284 ENERGY SPECTRUM OF PRIMARY PROTONS IN THE 10^{10}- TO 10^{13}-eV RANGE AS MEASURED BY PROTON-1 AND PROTON-2. Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A.; Titenkov, A. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1225-8(1967). (In Russian).

The SEZ-14 particle counter and spectrometer, designed for charged-particle counting on Proton satellites, is described, and some data obtained from it are presented. The device uses an ionizing calorimeter to determine particle energy threshold and a proportional counter to identify particle types. The absorptive elements in the calorimeter were divided into nine layers with a net effective value of 386 g/cm^2, i.e., allowing registry of particles up to 15 BeV. The geometric factor Γ of the counter was 420 cm^2/ster. Comparative data for both satellites taken over a 6 minute interval are shown. Possible errors in measurements are discussed, and assumed drift of discriminator thresholds by ±10% is included. It is noted that the spectral index γ obtained was considerably higher than values reported elsewhere in the literature. (ATD)

11285 ENERGY SPECTRA OF PRIMARY COSMIC PARTICLES IN THE 10^{10}- TO 10^{14}-eV RANGE RECORDED BY PROTON-1 AND PROTON-2. Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skyridin, G. A.; Titenkov, A. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1222-4(1967). (In Russian).

Brief preliminary results are given of the primary cosmic-ray flux that was recorded by the Proton-1 and Proton-2 satellites. The satellites used identical two-section ionizing calorimeters with photoelectric sensing elements. Each counter had eight threshold levels set to cover the energy range from 5×10^{10} to 10^{14} eV. The instruments were calibrated on earth by μ mesons, after which the lower threshold sensitivity was dropped by a factor of 10 so that only $\geq 10^{10}$ eV particles could be registered in flight. The count rate from Proton-1 was essentially constant throughout. The count rate from Proton-2 could be classified into three groups: 1st to 639th orbit, 773rd to 1043rd orbit, and 1187th to 1496th orbit (no analysis of this difference is given). Summarized data from both vehicles in terms of integral flux above a given energy level are shown. It is noted that the intensity at 10^{10} eV, i.e., 5×10^{-2} particles/cm^2/sec/ster, agrees within an order of magnitude with proton counts at that energy reported by several other authors. (ATD)

11286 HIGH-ENERGY COSMIC RAYS. Bunner, Alan N. (Univ. of Wisconsin, Madison). Sky Telesc., 34: 204-8(Oct. 1967).

Recent advances in knowledge concerning cosmic radiation are reviewed, and the observation of cascade phenomena resulting from ultra-high-energy particles is described. The only cosmic particles having kinetic energies greater than 10^{15} eV that have been identified with certainty are the positively charged nuclei of the lighter elements, mostly hydrogen (protons). The flux of charged particles arriving at the Earth is discussed in terms of 3 energy regions. The most numerous particles have kinetic energies less than 10 GeV, and are strongly affected by the Sun's magnetic field, especially at maximum solar activity. The Sun itself makes a negligible contribution to the cosmic-ray flux above 10 GeV. The intermediate energy region, from 10 to 10^4 GeV, has been extensively studied by experiments with nuclear emulsions carried to the top of the atmosphere. Above 10^4 GeV, cosmic-ray particles are very infrequent compared to those of lower energy. The study of air showers by means of charged particle detectors, such as Geiger counters, scintillation counters, and spark chambers, to sample the density of penetrating mu mesons or electrons that survive at ground level, is discussed. The results of some experiments are summarized. The frequency of arrival of ultra-high-energy particles (above 10^{19} eV) was found to be of the order 1/km^2/month. A technique devised to permit detection of the shower produced by a single proton 30 km away is explained. A 25-sided observatory building was designed to take advantage of the fact that nitrogen luminescence is emitted in all directions from the axis of the cosmic-ray air shower. Thus the event can be seen as far away as atmospheric conditions allow. The observatory views the night sky with 505 photomultiplier tubes, each tube looking at a separate region of sky. The signals from the phototubes are individually displayed on 505 3-inch cathode-ray tubes, arranged in a pattern that maps the sky, then simultaneously photographed by a 70-mm camera. Study of cosmic-ray showers by their Cherenkov radiation is also considered, as well as another method of detecting cosmic-ray air showers by the detection of the rf signal generated by the secondary particles in the atmosphere. (BBB)

11287 THREE-DIMENSIONAL MONTE CARLO SIMULATION OF EXTENSIVE AIR SHOWERS. Bradt, Hale V.; Rappaport, Saul A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 164: 1567-83(Dec. 25, 1967). (MIT-2098-367).

A three-dimensional Monte Carlo simulation of extensive air showers (EAS) with primary energies between 10^{14} and 10^{16} eV was carried out. The experimentally observable effects of three interaction models and two primary particles (Fe and proton) were determined. In all, some 500 simulated EAS at three primary energies were analyzed at two atmospheric depths: 530 and 970 g cm^{-2}. This analysis yielded average lateral distributions and energy spectra of nuclear-active particles (n.a.p.) and muons, together with the extent of the fluctuations in these quantities. The calculations also yielded the size of each EAS. This, in turn, enabled us to calculate measurable quantities normalized to shower size for comparison with experimental data. Our principal results and conclusions are as follows: (1) The extent of the fluctuations in shower size N_e for a fixed primary energy E_0 is about a factor of 2 at mountain altitudes (530 g cm^{-2}) and as much as a factor of 30 at sea level. Thus, at 530 g cm^{-2}, N_e is a good measure of the primary energy. (2) The extent of the fluctuations in the total n.a.p. energy per shower normalized to N_e, for EAS with Fe primaries (Fe-EAS), is less than $\frac{1}{25}$ of that for EAS with proton primaries (p-EAS). Data from a n.a.p. detector of large area and good energy resolution could thus yield meaningful results concerning the primary composition. (3) The relative number of high-energy nucleons to pions at 530 g cm^{-2} is significantly greater for Fe-EAS than for p-EAS. However, our calculations do not take into account the possibility of copious nucleon-antinucleon production at high energies in EAS. (4) The effect of introducing a few very high-energy pions (from isobar decay) into a two-center production spectrum is small compared to the effect of substituting Fe primaries for proton primaries. (5) The distribution of transverse momentum that we adopted [$f(p_t) \propto \exp(-p_t^2/p_0^2)$, $\langle p_t \rangle_{av} = 350$ MeV/c] yields steeper lateral distributions than those observed experimentally. It is thus deficient in particles of large p_t. (auth)

11288 CALCULATION OF A FUNCTION OF ANGULAR ELECTRON DISTRIBUTION IN SHOWERS IN ARBITRARY BOUNDARY CONDITIONS. Bakhtadze, A. K. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 39-49(July-Aug. 1967). (In Russian).

Electromagnetic cascade theory equations were resolved by approximations of small angles of multiple scattering at arbitrary boundary conditions. The cross sections of basic bremsstrahlung processes and pair formation were taken, considering the Bethe–Heitler shape and polarization of the media. The solution for the initial electron which holds for the finite magnitudes E/E_0 was analyzed. (tr-auth)

11289 ENERGY CHANGES OF COSMIC RAYS IN THE SOLAR SYSTEM. Jokipii, J. R.; Parker, E. N. (Univ. of Chicago). Planet. Space Sci., 15: 1375-86(Sept. 1967).

The energy (in the fixed frame of reference) of a cosmic-ray particle with velocity w in the frame of the solar wind fluctuates between $\frac{1}{2}M(w+v)^2$ and $\frac{1}{2}M(w-v)^2$ as the particle random walks in the magnetic field (where v is the wind velocity). This energy change cannot be treated as a simple Markov process, together with the random walk and adiabatic deceleration, in a fixed frame of reference. In order to describe the particle motion by a Fokker–Planck differential equation, the energy variable must be the particle energy in a frame of reference moving with the wind. The appropriate transformations of both the solutions and boundary conditions are presented to order v/w. The corrections due to this effect are ~10% for 1 MeV particles, and correspondingly less for higher energy particles. The energy balance between the solar wind and cosmic rays is examined, and is shown to depend in a fundamental manner on these energy transformations. Although the solar wind does net work on the cosmic-ray gas, no particle gains more than 2 Mvw kinetic energy, and the few particles which penetrate deeply into the solar system suffer a net energy loss because of adiabatic deceleration. (auth) (UK)

11290 COSMIC RAY-PRODUCED RADIONUCLIDES AS TRACERS OF ATMOSPHERIC PRECIPITATION PROCESSES. Wogman, N. A.; Thomas, C. W.; Cooper, J. A.; Engelmann, R. J.; Perkins, R. W. (Battelle Memorial Inst., Richland, Wash.). Science, 159: 189-92(Jan. 12, 1968).

Through recent developments in instrumental analysis it is now possible to measure with good precision the rainwater concentrations of five short-lived radionuclides which are produced by cosmic-ray spallation of atmospheric argon. These measurements provide a method for studying the in-cloud nucleation times and aerosol scavenging efficiencies, and promise to provide information on short-term processes which occur in rain and snow formation. (auth)

Direct Energy Conversion

Refer also to abstract 11444.

11291 (ANL-7188) REDUCTION OF ELECTRICAL END LOSSES IN MHD GENERATOR CHANNELS BY INSULATING VANES. Moszynski, Jerzy R. (Argonne National Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

A conducting-paper analog study was made of the effectiveness of various vane configurations in reducing electrical end losses. The applicability of established friction-loss correlations to vaned channel geometries was studied. Also an evaluation was made of multiple-vane configurations in terms of their influence of both electrical and friction losses. This evaluation led to selection of a vane configuration capable of reducing the electrical end losses significantly, with only minor increases in friction losses. (M.O.W.)

11292 (ANL-7377) EXPERIMENTAL INVESTIGATION OF LOW-PRESSURE ALKALI-METAL THERMIONIC CONVERTERS FOR DC AND RF POWER. Richards, Hans K. (Argonne National

Lab., Ill.). Sept. 1967. Contract W-31-109-eng-38. 72p. Dep. CFSTI.

Experiments with a low-pressure thermionic converter have been conducted with cesium, potassium, and sodium metal vapors. These metals provided for the neutralization of the electron space charge and the reduction of the collector work function. A tantalum emitter was brought to the desired temperature by electron bombardment. A molybdenum collector and guard ring were situated opposite the collector. The emitter–collector distance could be varied several millimeters by means of a micrometer control. The investigation included the dc electron current, output voltage, and power as a function of emitter temperature, vapor pressure, emitter–collector distance and effect of the different alkali metals. Covered in the investigation was the production of high-frequency oscillations (rf). The frequency, rms voltage, and power output were reported in detail as functions of the dc collector voltage, emitter temperature, emitter–collector distance, vapor pressure, and alkali metal. In addition, a dc–rf interaction was observed and analyzed. For this purpose, the rf and dc sections were separated by capacitance–inductance networks. Photos from an oscilloscope showed the amplitudes and wave shapes of the rf output. The results were also discussed as to their application for the design of thermionic reactor fuel elements. Special consideration was given to the relative merits of different alkali metals for neutralization of the space charge and reduction of the collector work function. (auth)

11293 FIRST SOVIET EXPERIMENTAL POWER PLANT WITH MHD GENERATOR NOW OPERATIONAL. Orlov, Vladimir. Nauka Zhizn, No. 6, 2-7(1967). (In Russian).

Design and operation of the first Soviet experimental power plant with a magnetohydrodynamic (MHD) generator are described. The new power plant (U-02) is being used to study the behavior of materials subjected to high temperatures in an erosive medium. The U-02 generator was constructed by the Ministry of Power Engineering and Electrification of the USSR under the scientific guidance of the Institute of High Temperatures. An old hydroelectric installation used for Moscow street cars was a adopted for the plant site. Unlike some MHD generator models, which possess many of the design features of rocket engines and have a very short operational life, the U-02 plant was designed for long operation as a stationary thermal electric power plant. The inside of the burner chamber, which is coated with heat-resistant ZrO_2, reaches a temperature of 2600°C. An injection apparatus is used to seed the flame. The high-temperature chamber has operated successfully for more than a thousand hours, withstanding many start-ups and stops. Electromagnets of 100-ton size were used. The electrodes are of ZrO_2 also, which in the hot gases temporarily become conductors. Magnesium oxide bricks are used as insulators. Work is being conducted on removal of K from the plasma by use of special glass-fiber filters housed in silvered columns. In experiments with hot electrodes, the specific power reached ~2000 kW/m^3 of working volume of the generator. The direct current from the generator's electrodes was transformed into standard alternating current. The power produced at the new MHD plant is fed into the Moscow power network. These experiments in design of an MHD power plant have led to the design and initial construction of a large semiindustrial-type power plant incorporating an MHD generator with a rating of 25,000 kW. (BBB)

11294 TWO-PHASE MAGNETOHYDRODYNAMICS. Bidard, R. (Compagnie Electro-Mecanique, Paris). Rev. Gen. Elec., 76: 898-905(June 1967). (In French).

MHD devices employing liquid metals are considered. Principles are described, and the relative merits and disadvantages with respect to devices using plasmas are outlined. The inconveniences are chiefly of a thermodynamic nature, since liquids are not thermoelastic and an exchanger must be employed. Solutions to these problems which have already been devised are considered. These are divided into two categories: those which employ a gas separator, and those which do not. For better design it is necessary to transfer energy from gas to liquid with small losses in velocity, never attain great velocities in the liquid, maintain reasonably constant temperature in the liquid, never enter or leave a magnetic flux with a liquid conductor debit or at least with only a small percentage of the total liquid debit. A single generating loop operating by a gas–liquid emulsion is analyzed, as is a group of concentric loops designed to improve the thermodynamic cycle by fractioning of expansion. (BBB)

11295 APPLICATION OF ELECTROCHEMICAL METHODS TO THE STUDY OF MHD ELECTRODES. Guillou, M. Rev. Gen. Elec., 76: 58-68(Jan. 1967). (In French).

In their use as materials for hot MHD electrodes, solid electrolytes such as stabilized zircons are inserted between 2 electric conductors: the current collector and the plasma. The whole assembly of current, electrode, and plasma then constitutes an electrochemical cell. Electrochemical criteria on the functioning of ceramic materials such as refractory oxides used as constituent materials in electrodes are established and preliminary results given. Preliminary results were made for zircon–praseodymia, zircon–magnesia, and zircon–neodymia; the possibility of eliminating destructive electrolytic phenomena by transport of O to the cathodic ceramic-current collector interface is proposed. Porous ceramics with totally ionic conduction or mixed electron-ion conduction could be used to prepare hot MHD cathodes which would function satisfactorily if the electrode material was regenerated by O during its use. Zircon–neodymia transports principally ionically, while the Pr system has a large part due to electrons. (BBB)

11296 DRIFT-FIELD SOLAR CELLS ON SILICON WEB. Tarneja, K. S. (Westinghouse Electric Corp., Youngwood, Pa.); Riel, R. K.; Hicks, J. M.; Babcock, R. V. J. Spacecraft Rockets, 4: 1663-7(Dec. 1967).

Drift-field solar cells on silicon web material have been developed. Epitaxial growth techniques were used to obtain graded layers for achieving the drift-field structure. Since web material is used, the cells are much larger in area than ones fabricated with conventionally grown silicon. The cells were optimized for radiation resistance with the aid of 1-MeV electron damage data. Additional 1-MeV electron damage testing indicated that the optimum epitaxial graded-base cells are more radiation resistant than the conventional (field-free) cells. The drift-field cell (protected by a 3-mil cover glass) is compared with the conventional cell (protected by a 12-mil cover) in a projected five-year equatorial synchronous earth orbit. The calculated results indicate that the drift-field cell has about the same terminal efficiency but reduced weight because of the thinner cover, and it has a greater efficiency if the same cover thickness is used. (auth)

11297 THERMAL POWER PLANT WITH MHD GENERATOR. Keller, C. (to Escher Wyss Aktiengesellschaft). Canadian Patent 764,052. July 25, 1967. Priority date Nov. 7, 1963, Switzerland.

From the MHD generator the heat transfer fluid which has secured energy from a nuclear reactor, is passed at high temperature (up to 2000°C) to a gas turbine to drive a secondary generator. Then the fluid is compressed, heated and returned to the MHD generator where it is reactivated. In another embodiment, a heat exchanger is added and separate fluids are used in the gas turbine and the MHD generator. Such arrangements claim good utilization of the thermal energy in the active fluid after leaving the MHD generator. (F.S.A.) (Canada)

11298 FUEL CELL. Iijima, Hiroshi (to Japan Steel and Tube Corp.). Japanese Patent 1967-2496. Feb. 3, 1967. Filed July 28, 1962.

The fuel cell proposed has a high output, and its construction is simple. In addition, it is capable of easy, industrial manufacturing. On both sides of the fuel cell are placed radioisotopes with some distance from the cell wall; they are in their shield which is open in the direction of the fuel cell. The plate electrodes in the cell are irradiated with the radiation from the radioisotopes, which penetrates through the cell wall. (NSA of Japan)

11299 IMPROVEMENTS IN MAGNETOHYDRODYNAMIC INSTALLATIONS. (to Societe Generale de Constructions Electrique et Mechaniques (Alsthom)). British Patent 1,096,773. Dec. 29, 1967. Priority date Apr. 20, 1964, France.

A MHD generator installation is described which facilitates the reheating, the recycling of a large part of the energy in chemical form, and the recovery of the seed. The installation includes a MHD converter supplied with hot gases from a combustion chamber. It comprises a reaction chamber wherein a fraction of the exhaust gases is mixed with fuel, means for recovering the seed from the reacted gases, a burner receiving the deseeded reacted gases, and a heat exchanger receiving the burner gases and arranged to preheat the medium supplying the combustion chamber. The other exhaust fraction supplies heat to the main fuel and to the combustion air, before supplying a steam plant. (D.L.C.)

11300 ELECTRICAL CHARACTERISTICS AND TRANSIENT WAVE GROWTH IN MAGNETOGASDYNAMIC CHANNELS. Powers, Walter Lee. Knoxville, Tenn., Univ. of Tennessee, 1967. 94p.

Thesis.

A graphical display of the generalized Ohm's law which is assumed to describe the local electrical characteristics of magnetogasdynamic (MGD) generators and accelerators is presented. Ion slip and electrode-sheath voltage drop are included, but viscous effects are excluded. A performance map is drawn in terms of dimensionless electrical parameters. The operating features of

the segmented diagonal conducting wall (DCW), segmented Hall, continuous electrode (CE), and segmented Faraday generators and accelerators are represented on the same map for purposes of comparison. The operating equations pertinent to each of the special devices are also written in terms of the dimensionless quantities. It is shown how this map may be used in evaluating MGD channel performance, and how it materially aids in channel design and in selecting the most desirable type device for a given requirement. The internal and external sets of equations are solved simultaneously to give the electrical parameters in terms of the external resistivity which is the primary parameter in determining the operation mode of MGD generators. This permits the entire range from short to open circuit to be studied. Operation at maximum generator efficiency, Hall neutralized current, and maximum power output is also discussed. A first-order perturbation analysis of the continuity, momentum, and energy equations coupled with the generalized Ohm's law is made. This permits an investigation of the initial development and growth of the transient acoustical response to natural disturbances which may disturb uniform flow conditions in MGD generators. Fluctuations in the Hall parameter and especially the electrical conductivity are primarily responsible for longitudinal wave growth due to their dependence on the fluctuating gas temperature, pressure, and density. A cubic dispersion relation with complex coefficients results from a one-dimensional plane wave traveling in the channel axial direction. The cubic is solved numerically for various typical sets of steady-state operating values, and for all disturbance wavelengths of interest in the DCW, Hall, CE, and Faraday generators. This study differs from other works in that: the steady-state gradient terms are not neglected; the adiabatic approximation is not made; the cubic is solved numerically rather than by approximate algebraic expressions; all four generators are investigated; and solutions are obtained for all operating external resistivities of interest. Results show that under certain conditions the upstream and enthalpy waves can pick up energy from the gas causing considerable increase in their amplitudes during the time spent in a typical channel. (Disser. Abstr.)

11301 MAGNETOHYDRODYNAMIC GENERATOR. (to Compagnie Generale d'Electricite). British Patent 1,096,703. Dec. 29, 1967. Filed July 28, 1964, France.

A particular closed-loop MHD generator is described. (M.O.W.)

Fluid Physics

11302 INTERACTION OF A TRAVELING MAGNETIC FIELD WITH RIGID CONDUCTING SPHERES OR CYLINDERS. Thome, Richard J. (Massachusetts Inst. of Tech., Cambridge). Contract AF 33(615)-3489. Proc. IEEE (Inst. Elec. Electron. Eng.), 55: 2116-22(Dec. 1967).

The case of a rigid conducting sphere or cylinder that travels with uniform velocity relative to a two-dimensional, primarily transverse magnetic field with sinusoidal variation in space and time is analyzed to determine the electromechanical characteristics of the interaction. Interest is centered on conductors with diameters small relative to the wavelength of the applied field. For the sphere, an exact solution is not tractable by standard techniques, hence, a method is utilized in which the force is approximated by one of its components. The results are verified by: 1) applying the approximation to the analogous case of a cylinder and comparing the result with the exact solution to that case, 2) comparing the limit of the approximate solution for the sphere with the result obtained by assuming the magnetic Reynolds number to be small, and 3) determining the net time-average force of electromagnetic origin experimentally for comparison with the predictions of the theory. The latter were carried out for the cylinder as well as the sphere over a range of magnetic Reynolds numbers ($sR_m = \mu_0\sigma s\omega D^2$) from 0.4 to 20. In the course of the work, a method is also utilized in which the original "skin effect" problem is reduced to a problem involving interacting low sR_m components and the force is found via the techniques of lumped parameter electromechanics. The study is concluded with a determination of the condition under which two spheres or cylinders are electromagnetically independent so that the results for a distribution of conductors may be obtained by superposition of the results for a single body. Situations which may be modeled using the results of this study include holdup or separation of a highly conducting liquid phase from a two-phase flow in heat transfer apparatus as a result of the application of a magnetic field gradient or the energy conversion in a liquid-metal MHD induction machine with a two-phase working field. (auth)

11303 SOME INTRINSIC PROPERTIES OF STEADY PARALLEL FLOWS IN MAGNETOFLUIDDYNAMICS. Suryanarayan, E. R. (Univ. of Rhode Island, Kingston). J. Math. Anal. Appl., 20: 403-15(Dec. 1967).

Three-dimensional steady parallel flows of inviscid magnetic fluids are considered. Parallel flows have the property that the fluid velocity and magnetic field are locally parallel. The geometry of such flows is investigated. (W.D.M.)

11304 MERCURY FLOW IN CIRCULAR PIPES IN THE PRESENCE OF TRANSVERSE MAGNETIC FIELD. Branover, G. G.; Vasilev, A. S.; Gelfgat, Yu. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 55-7(1967). (In Russian).

Experimental data are presented on the drag coefficient of mercury flow in the presence of a transverse magnetic field. (auth)

11305 GEOMETRY OF MAGNETOHYDRODYNAMIC FLOW. Wasserman, Robert H. (Michigan State Univ., East Lansing). Quart. J. Mech. Appl. Math., 20: 219-31(May 1967).

A specific system of partial differential equations, the representation usually attributed to Lundquist of magnetohydrodynamic (MHD) flow, is examined to determine whether this model is an adequate one. The Lundquist formulation consists of 9 partial differential equations, and corresponding to each solution there will be families of streamlines, field lines, constant pressure surfaces, and other families of curves and surfaces. To what extent the forms of these curves and surfaces are determined by the equations or to what extent the prescription of these curves and surfaces determines the other properties of the flow is described. In harmony with such a geometrical approach this analysis is restricted to steady flows and avoid assumptions of geometrical symmetry such as restriction to plane or aligned flow. It is also restricted to nondissipative flow. In the 2 main approaches described, first 2 formulations equivalent to the Lundquist formulation were derived. Each consisted of 3 higher order partial differential equations and expressed largely in terms of the geometry of the streamlines and field lines. These are the results stated as 4 theorems. Secondly, these new formulations were used to show that the streamline and field line congruences essentially determine everything else about the flow (in 2 additional theorems). (BBB)

11306 MAGNETOGASDYNAMIC BOUNDARY LAYER FOR A THERMALLY CONDUCTING PLATE. Ingham, D. B. (Univ. of Leeds, Eng.). Quart. J. Mech. Appl. Math., 20: 347-64(Aug. 1967).

An analysis is made of the flow in the boundary layer on a semi-infinite flat plate placed at zero incidence to a uniform stream of electrically conducting gas with an aligned magnetic field at large distances from the plate. Equations governing the flow, magnetic field, and temperature were derived for any heat-transfer condition at the plate. Six parameters are involved, namely the Prandtl no., Pr, γ, $\epsilon = 4\pi\mu\sigma_\infty\nu_\infty$, $\beta = \mu H_\infty^2/4\pi\rho_\infty U_\infty^2$, $M^2 = U_\infty^2/c^2$ and the temperature difference $T_p - T_\infty$ or the temperature gradient $(\delta T/\delta y)_p$; a complete solution would therefore be difficult to obtain. Two different cases are considered; (1) the plate is thermally insulated, i.e., the problem of the plate thermometer; (2) the plate is maintained at any given temperature, which for the purpose of numerical analysis was taken to be that of the main stream. The equations were integrated numerically taking $\epsilon = 0.1$, $\beta = 0.3$ and 0.5, and $\epsilon = 0$, $\beta = 0$ in all 3 cases for Pr = 1, $\gamma = 1.4$, and $M^2 = 0$, $\frac{1}{2}$, 1, 2, 5, 10, and 25. For given values of β and M the effect of changing the boundary conditions from (1) to (2) is to increase both the skin fraction and tangential component of magnetic field at the plate and also to increase the width of the boundary layer slightly. It was found that increasing the magnetic field for a given Mach number, or decreasing the Mach number for a given magnetic field thickens the boundary layer. (BBB)

11307 EXPERIMENTAL INVESTIGATION OF SELF-SUSTAINING ELECTRICAL DISCHARGE IN SUPERSONIC GAS FLOW ACROSS TRANSVERSE MAGNETIC FIELD. Vitshas, A. F.; Golubev, V. S. At. Energ. (USSR), 23: 291-5(Oct. 1967). (In Russian).

The results of the experimental study of the azimuthal electric current in plasma induced by the motion of gas across a magnetic field were reported. It was shown that the energy loss of the electrons is compensated on account of the decrease of the kinetic energy of the directed gas flow. The electron concentration was measured by the radiation of the continuum and the magnitudes of the field in the plasma by the probe method. The distribution of the electron concentration was obtained by processing photographs of the plasma, taken by means of electron-optical converter with exposure of 5 μsec. The results obtained confirmed the theoretically predicted decrease of the effective conductivity of the plasma, caused by the presence of heterogeneity of the electron concentration. (tr-auth)

11308 UNITARY PRINCIPLE FOR STATIONARY FLUX IN MAGNETOHYDRODYNAMICS. Foerste, J. (Forschungsgemeinschaft, Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 9: 241-7(1967). (In German).

A boundary value problem with T a limited range of the 3-dimensional space with the boundary S is formulated. An a priori evaluation is made of the solution. The unitary principle is then introduced. (J.S.R.)

11309 MAGNETOHYDRODYNAMIC BOUNDARY LAYER OVER A FINITE DIELECTRIC DISC. Glazov, O. A. (Inst. of Physics and Power Engineering, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 58-67(1967). (In Russian).

The magnetohydrodynamic boundary layer over a finite dielectric disk for rotating flows of incompressible fluid is considered. Solutions are obtained by the two-parameter integral method. As a profile of the velocity in the boundary layer exact solutions for a large magnetic field are used. (auth)

11310 UNSTEADY MOTION OF LIQUID NEAR DISC ROTATING IN MAGNETIC FIELD. Pop, I. (Kluzh State Univ., Rumania). Inzh.-Fiz. Zh., 12: 793-8(June 1967). (In Russian).

The unsteady motion of an incompressible electric-conducting viscous fluid near a rotating disc in the presence of a constant transverse magnetic field is studied. (auth)

Geophysics

Refer also to abstracts 10662, 11018, 11186, 11251, 11255, and 11257.

11311 (CEA-Bib-103) LES CEINTURES DE RADIATIONS DE VAN ALLEN. (The Van Allen Radiation Belts). Touzain, Philippe (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Dec. 1967. 39p. (In French). Dep.

Thesis.

The Van Allen radiation belts are studied with the bibliography results published before May 1967. The trapped particles motion in the magnetosphere, their origins and their disappearances, the position in space of electron and proton zones, and finally, the 1962 nuclear explosions and South-Atlantic anomaly influence, are successively examined. (auth)

11312 ON THE INTERMEDIATE IONOSPHERE LAYERS E2 AND F0. Kasymova, A. G. (Inst. of Geophysics, Kiev). Geofiz. Astron. Inform. Byull., No. 9, 110-23(1966). (In Russian).

The morphology of the intermediate layers E2 and F0 is studied by the data of several stations situated in both hemispheres. The diurnal, seasonal, and latitudinal variations of probability of appearance of layers E2 and F0 and their electron densities are given. The duration of reflection from E2 and F0 layers, their magnitudes, and dependence of PE2, PF0, f_0E2, f_0F0 on solar activity are discussed. (auth)

11313 ON THE NATURE OF THE INTERMEDIATE IONOSPHERE LAYERS E2, F0, F1.5. Kasymova, A. G. (Inst. of Geophysics, Kiev). Geofiz. Astron. Inform. Byull., No. 9, 124-9(1966). (In Russian).

The correlation between the appearance of intermediate ionosphere layers E2, F0 and other geophysical phenomena is discussed, and the opinion is advanced that E2 and F0 are separate layers. (auth)

11314 PRELIMINARY RESULTS OF A STUDY OF MOTIONS OF SMALL-SCALE INHOMOGENEITIES IN THE LOWER IONOSPHERE IN THE VICINITY OF THE COASTAL LINE OF THE BLACK SEA. Karnaushenko, N. N. (Marine Hydrophysical Inst., Kiev). Geofiz. Astron. Inform. Byull., No. 9, 130-3(1966). (In Russian).

The results are presented of a study of the drifts of small-scale inhomogeneties in layers E_1, E_s, and F of the ionosphere in the vicinity of coastal temperature contrasts. The period of observations embraces 1964. A preliminary processing of the data by the similitude method and a harmonic analysis reveal predominating drifts of a seasonal and local nature in the ionosphere. The seasonal regularity of the drifts is particularly distinct in the lower layers of the ionosphere. Qualitatively different pictures are obtained for drifts of inhomogeneities in layers E and F of the ionosphere. (auth)

11315 DURATION OF THE EXISTENCE OF SPORADIC E OVER KIEV. Bondarenko, V. I. (Inst. of Geophysics, Kiev). Geofiz. Astron. Inform. Byull., No. 9, 134-6(1966). (In Russian).

The stability of existence of the sporadic layer E_s is considered. Data obtained at the ionosphere station at Kiev in 1962 were used. A seasonal variation of the stability of E_s was detected, rigorously connected with the seasonal course of probability of its appearance by a direct dependence. The nature of E_s distribution by duration was also found to change from season to season. (auth)

11316 EFFECT OF THE 27-DAY SOLAR CYCLE ON THE TEMPERATURE FIELD OF THE TROPOSPHERE. Smirnov, R. V. (Marine Hydrophysical Inst., Kiev). Geofiz. Astron. Inform. Byull., No. 9, 162-4(1966). (In Russian).

The results are given of an investigation of the geomagnetic activity and temperature of the terrestrial layer of the troposphere by the 27-day solar calendar. It is shown that there is a tendency towards a 27-day recurrence from the range of temperature values. This is corroborated by the correlation between the values of the magnetic activity and temperature for several periods of the eleven-year cycle. The reality of the correlation is evaluated statistically. (auth)

11317 INTRODUKTION TILL GEOKOSMOFYSIKEN. (Introduction to Geocosmic Physics). Hultqvist, Bengt. Stockholm, Natur och Kultur, 1967. 271p. Sw. Crs. 31.50 (paperback), Sw. Crs. 36.50 (bound). (In Swedish). (NP-17227).

The main purpose of this book is to be an introductory textbook in geocosmical physics at universities and institutes of technology in Scandinavia. The following topics are reviewed: the Earth's magnetic field; composition, mechanical, and thermal properties of the upper atmosphere; interaction of solar radiation with the upper atmosphere; the ionosphere; variations and disturbances in the magnetic and electrical fields of Earth; the polar aurora; theories of geomagnetic storms; galactic radiations; solar radiation; the Van Allen belts; and instrumentation, measuring methods, and devices within geocosmical physics. (Sweden)

11318 ON THE RELATION BETWEEN THE E LAYER AND THE SUN. Serafimov, K. (Geophysical Inst., Sofia). Beitr. Geophys., 75: 222-30(1966).

Some expressions were derived for the variations of the E layer critical frequency (f_0E) as affected by the solar zenith angle, taking into account the influence of the gradient and the variations with time of the height scale. By consideration of the seasonal changes of the recombination coefficient and the height scale, it was theoretically confirmed that the daily value of the index n of the cosine law for the E layer does not coincide with the noon value. The theoretical analysis is illustrated with data for n taken from the Dourbes station. The results show a very small dispersion for n dependent on the season (having its maximum during summer and minimum during winter). A decrease of n in the noon period was observed mainly in summer. A forenoon decrease of f_0E was observed at $\chi = 70°$ to 82°. The value of n determined on the basis of forenoon values of f_0E often differed from that based on the afternoon values. For n, values were obtained of between 0.30 and 0.37. The juxtaposition of data for Dourbes and Sofia ($n = 0.21 + 0.4$) shows the influence of the site at which the measurements were taken as regards the S_q current system. The n values agreed with the solar x-ray emission in the range $\lambda\lambda$(44 to 60 Å), the correlation coefficient being 0.82. The following relation could be used for n: $\bar{n} = a(1 + b\bar{F})$. For Sofia a = 0.1, while for Dourbes a = 0.19. For both stations b = 0.53. (BBB)

11319 DEPENDENCE OF THE BOUNDARY FREQUENCIES OF THE E_s LAYER ON THE SOLAR ZENITH ANGLE. Samardjiev, Dimitar (Geophysical Inst., Sofia). Beitr. Geophys., 75: 255-60(1966).

The daily variations of the boundary frequencies of the sporadic layer of the c type were studied on the basis of data from several stations at moderate latitudes. The values of f_0E_s were fairly recurrent, slightly scattered, and displayed a smooth increase from morning to noon, as well as an equally smooth decrease in the afternoon, their maximum coinciding with the maximum solar height. A cosine law was established for the boundary frequencies ($f_0E_s \simeq \cos^n \chi$) of the E_s layer of the c type, with the index n of about 0.25. It is shown that the index in the cosine law does not depend on the solar activity cycle (1957 to 1964). An increase of the values of n was observed corresponding to an increase of the geographical latitude. (BBB)

11320 STATISTICAL ANALYSIS AND MODELING OF THE HIGH-ENERGY PROTON DATA FROM THE TELSTAR 1 SATELLITE. Gabbe, J. D.; Wilk, M. B.; Brown, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Bell Syst. Tech. J., 46: 1301-1450 (Sept. 1967).

Analysis of data from the omnidirectional high-energy proton detector on the Telstar 1 satellite led to the development of relatively simple (empirical) mathematical models giving a statistically accurate representation of the measured spatial distribution of intensity of protons with energies between 50 and 130 MeV. These models depend upon the fitting of 8 (or 9 or 10) coefficients based on samples containing ~1000 of 80,000 experimental observations. The nature of the model for the average omnidirectional counting rate permits its closed form transformation to the equivalent equatorial pitch angle distribution. A series of one-dimen-

sional fits was employed as a base for developing a 2-dimensional model. The data covered the period between July, 1962 and February, 1963, and the spatial region bounded by $1.09\ R_e \leq R \leq 1.95\ R_e$ and $0 \leq \lambda < 58°$. Flux maps with a relative accuracy of about 2% were derived from the fit and are illustrated. The temporal behavior of the intensity was examined and some changes noted. The maximum value of the omnidirectional flux of protons with energies between 50 and 130 MeV was found to be $[5.7^{+1.1}_{-2.2}] \times 10^3$ protons/cm^2 sec at L = 1.46 on the magnetic equator, in good agreement with other experiments. Relative flux values and energy spectra were consistent with the generally accepted picture of the proton distribution. (BBB)

11321 CATALOG OF GERMAN AURORA OBSERVATIONS FOR THE YEARS 1882–1956. SUPPLEMENT. **Schroeder, Wilfried. Beitr. Geophys., 76: 195-201(1967). (In German).**

Additional observations of aurorae in Germany are tabulated with respect to physical description and reference (cf. Beitr. Geophys., 75: 435-446(1966)). A table of frequency of occurrence of aurorae per year in Germany is as follows (years with no observations omitted): 1882, 2; 1886, 13; 1887, 8; 1888, 7; 1892, 6; 1893, 2; 1894, 2; 1895, 3; 1896, 1; 1897, 1; 1898, 1; 1902, 6; 1903, 3; 1905, 3; 1907, 1; 1908, 1; 1909, 2; 1910, 1; 1914, 2; 1916, 2; 1917, 1; 1918, 3; 1919, 1; 1920, 2; 1921, 8; 1922, 2; 1924, 2; 1926, 16; 1927, 2; 1928, 3; 1929, 9; 1930, 8; 1931, 1; 1932, 1; 1933, 1; 1934, 3; 1937, 10; 1938, 13; 1939, 5; 1940, 8; 1941, 11; 1942, 4; 1946, 9; 1947, 39; 1948, 17; 1949, 16; 1950, 8; 1951, 6; 1952, 1; 1955, 3; 1956, 5. An index to observers is also given. (BBB)

11322 THE DISPLAY OF THE AURORA OF 8 JULY 1958. **Schroeder, Wilfried. Beitr. Geophys., 76: 135-8(1967). (In German).**

A detailed investigation of the solar and geomagnetic data in relation to the aurora of July 8, 1958, was made. An eruption of class 3+ was observed. The planetary Kp indices reached 9 three times on 8 July; the Q index reached 8 23 times on 8 and 9 July. The aurora was observed in the northern hemisphere to latitude $\Phi = 38°N$ and in the southern hemisphere to $\Phi = 29°S$. The form in the northern hemisphere was mainly G, R, DS, and S; in the south, DS and RA. Brightness at medium northern latitudes was I–II. Most records indicate a red color in both hemispheres. The observations were from all over central Europe and from ships stationed in southern waters; a map illustrates the positions of the latter. The display ranks as one of the more important auroras of the last decade and is related to the solar flare. (BBB)

11323 NONSTATIONARY AND QUASISTATIONARY CONDITIONS IN THE D REGION OF THE IONOSPHERE. **Nestorov, Georgi (Geophysical Inst., Sofia). Beitr. Geophys., 75: 249-54(1966). (In German).**

A solution to the problem of equilibrium in the D region is proposed on the basis of multiannual absorption measurements by the A3 method. At moderate geographic latitude and solar zenith angle $\chi \geq 80°$ the D region should not be considered as being in an equilibrium condition, while at $\chi < 80°$ there is a considerable quasistationary approximation. At sunrise and sunset, during solar flares and solar eclipses, as well as in instances of marked deviation from the normal conditions, the D region should be considered as a plasma in a nonstationary condition. (BBB)

11324 STUDY OF THE IONOSPHERE BY MEANS OF ROCKET MEASUREMENTS OF A VLF FIELD EMITTED BY A GROUND SOURCE. **Renard, Claude (Groupe des Recherches Ionospheriques, Saint Maur des Fosses, France). Ann. Telecommun., 21: 267-82(Nov.-Dec. 1966). (In French).**

Measurements made in the ionosphere by rockets on the vlf magnetic field from a ground emitter were performed to determine directly collision frequencies and electron density along the length of the trajectory. The full wave method was developed for calculations and was applied to the determination of the characteristic of the vlf field using previously obtained parameters. Good agreement was found between theory and experiment, so that the simplified theory used is acceptable. Calculations for the region where the simplified theory is not valid (70 to 78 Km) are given. Values are calculated for demonstrating the special properties of vlf waves in the ionosphere. (BBB)

11325 DETERMINATION OF CONSTITUTIVE PARAMETERS OF THE IONOSPHERE BETWEEN 78 AND 100 KM OF ALTITUDE FOR THE LOCAL MEASUREMENT OF THE VLF FIELD RADIATED BY A GROUND EMITTER. **Renard, Claude (Groupe de Recherches Ionospheriques, Saint Maur des Fosses, France). Ann. Telecommun., 21: 117-35(May-June 1966). (In French).**

Experimental data on the frequency of electron–neutral collisions and on electron density of the ionosphere between 78 and 100 Km are presented. These values were obtained from the vlf field characteristics radiated by the emitter at Annapolis measured on two Aerobee 150 A rockets from Wallops Island. Equations are developed for the inclusion of the experiments within generalized magneto-ionic theory, and results are discussed. A vlf wave of 22.3 kHz propagates in the ionosphere uniquely following the whistling mode and with quasi-circular polarization from 76 Km. Between 70 and 100 Km this wave undergoes an absorption of about 16 dB. The real and imaginary parts of the index calculated by the generalized theory and the Appleton–Hartree theory are compared. (BBB)

11326 ROCKET EXPERIMENTS FOR THE INVESTIGATION OF NORTHERN LIGHTS. **Keppler, E. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.); Kirsch, E.; Moerl, P.; Musmann, G.; Rossbach, A.; Rossberg, L. Z. Geophys., 33: 346-61(Sept. 1967). (In German).**

Studies conducted in 1966 to investigate the energy spectrum, intensity, and temporal variations of protons and electrons in an aurora are reported. Data were also sought on electron precipitation and its correlation with optical and hydromagnetic measurements and on the energy spectrum, intensity, and temporal variations of solar protons in the ionosphere. Four experiments, which were flown on board a Nike–Apache rocket, are described. The experiments were designed to measure auroral zone phenomena by (1) a combination of G–M counters to detect directionally the precipitated and backscattered electron flux above 40 keV, (2) a proton counter which measured protons with energies above 30 MeV, (3) a filter-type photometer monitoring 3914 Å and 5577 Å auroral emissions, and (4) a vector magnetometer with a sensitivity of ±5γ. (BBB)

11327 THE IONOSPHERIC INDEX Φ_{F2}. **Joachim, M. Telecommun. J., 34: 354-6(Sept. 15, 1967).**

The elaboration of correlation functions for the 3 basic indices of ionospheric propagation, R_{12}, I_{F2}, and ϕ; the effect of ionospheric hysteresis to be seen in the behavior of I_{F2}; and a new method of predicting ϕ on the ITU computer are considered. The results suggest that it should now be possible to work out a new propagation index more closely correlated with ionospheric data and more accurately predictable than those now in use. The main basic criteria for such new index should be: determination from physical measurements rather than from empirical phenomena, elimination of the ionospheric hysteresis effect, if possible, and no negative values not subject to physical interpretation. The stations which normally supply such data submitted values for ϕ and f_0F2 for calculation of the I_{F2} and ϕ index. Study of the correlation between the values of ϕ and f_0F2 showed that there was no linear correlation between the solar and the ionospheric values. In fact, for all the stations used and for every month, an exponential correlation was found which could be represented in the semilogarithmic coordinates as a straight line. Thus, it is easy to determine which straight lines best fit the measured values of the index ϕ and the critical frequencies f_0F2. Values for the first tentative analysis are tabulated. Values were calculated for the median ionospheric index, ϕ_{F2}. This index is based on measurements of f_0F2 taken at noon at 9 ionospheric stations used for calculation of I_{F2}. The values of the ϕ_{F2} indicate that the general pattern is very similar to that of values for ϕ except that the abrupt variations from month to month are absent. Parameters of the regression curves for ϕ_{F2} were slightly different from the parameters of the same regression curves for ϕ vs f_0F2. This difference is explained in terms of a time lag between the values for f_0F2 and the values for ϕ. The values of these parameters are tabulated. When the numerical prediction method elaborated for the ITU computer was applied to the ϕ_{F2} values, the accuracy of prediction was found to be greater than with the ϕ predictions based on the same method. Thus, use of the ϕ_{F2} index would make it possible to reduce not only the scatter of the mean monthly values of F_0F2 by comparison with the predictions based on the ϕ index but also the scatter of the ϕ_{F2} values predicted by the numerical method. (BBB)

11328 THE DIRECTION OF MOVEMENT OF F2 REGION PERTURBATIONS. **Reddi, C. R.; Rao, B. R. (Andhra Univ., Waltair, India). Radio Electron. Eng., 34: 53-9(July 1967).**

The effect of large-scale variations in ion density in the F2 region of the ionosphere, presumably due to traveling wave-like perturbations, or the so-called traveling ionospheric disturbances, on the direction of arrival of the downcoming wave was investigated and a new method of measuring the direction of movement of the perturbation presented. The principle of the new method, of recording the phase path variations, is similar to Findlay's original technique of comparing the phase of the reflected signal from the ionosphere against a local reference oscillator, phase coherent with the transmitted pulse. Changes in the phase of the reflected signal produce movement of the beat pattern, produced after phase comparison, detection, and further amplification along the length of the time base displaying it. Changes of phase path due to traveling ionospheric perturbations were recorded with 3 closely spaced antennas. The results of the analysis using this method for 151 perturbations are presented. It was found that the direction of

movement of perturbations with quasi periods of about 15 min and maximum height changes of about 2 to 3 km is within 230 to 250° to the east of north at a low-latitude station, Waltair. The direction of movement of these perturbations was found to be independent of the time of the day. (BBB)

11329 ASPECTS OF THE WINTER ANOMALY IN THE IONOSPHERIC E LAYER. Serafimov, Kyril; Samardjiev, Dimitar (Geophysical Inst., Sofia). Beitr. Geophys., 76: 89-105(1967).

Existing data and explanations of the winter anomaly in the E layer are examined and the shortcomings of analyses made from ionospheric data are pointed out. Criteria are defined for the existence of an anomalous state on the basis of the seasonal changes and those of the critical frequencies f_0E and the aeronomic parameters σ, H_0, and α according to solar activity. An optimum zone of geographic latitudes was determined for the study of the possible phenomena without the interfering influence of the periods of sunrise and sunset, of the diurnal changes in α, and of the midday effects. The data from 2 medium-latitude stations (Moscow and Dourbes) over an 8-yr period (1957 to 1964) were studied and it was established that a winter anomaly appears only after failure to take account of the theoretically established correlations. Effects connected with the diurnal asymmetry in the critical frequencies of the E layer also have an influence on the anomalous state. No winter anomaly was found in the electron concentration of the E layer when the influence of all factors was taken into account. It was confirmed that f_0E for identical zenith angles of the Sun is to a great extent determined by the relative number of sunspots, the correlation coefficient between them being 0.93. The critical frequencies depend also on the radio emission of the Sun I_{1500} (coefficient of correlation r = 0.72). Analysis of the data from 46 ionospheric stations situated throughout the world showed the need for taking into account the geographic latitude and probably the geomagnetic coordinates. After correction of the ratio f_0E_S/f_0E_W, even only for changes due to solar activity, it was found that the winter anomaly disappears in data from most of the stations under study. When the seasonal changes of the aeronomic parameters were also accounted for, this anomaly was eliminated. (BBB)

11330 RESULTS OF COSMIC RADIO NOISE RECORDING AT MIRNY OBSERVATORY IN 1962. Driatskii, V. M. Sov. Antarct. Exped. Inform. Bull., 5: No. 54, 411-14(1965).

Continuous recording of cosmic radio noise, for the study of radio wave absorption in the ionosphere, was performed by the Seventh Soviet Antarctic Expedition at a frequency of 31.8 Mc at Mirny Observatory (66°33′S and 93°01′E) in 1962, using a riometer. A 3-element antenna of the wave-duct type, pointing toward the zenith, was utilized for radio noise reception. The cosmic radio noise records obtained showed several instances of auroral absorption. All these events had the form of bay-like radio noise intensity decreases and were accompanied by corresponding bay-like disturbances of the geomagnetic field. Duration of the bays, magnitude of maximum absorption, and time of the maximum were examined. Most events were observed during the Antarctic winter (May–August) and spring (September–October). The absorption events concentrated around midnight. The diurnal pattern was different during the Antarctic summer and autumn. Few absorption events were observed at this time, and did not have a maximum around midnight and appeared with equal probability throughout the night. Absorption bays were extremely rare during the daytime. Bays of a duration from 20 to 60 min were most frequent, comprising 76% of the total number of absorption events. Absorption of an intensity from 0.3 to 1.0 db was most frequent: 65% of the total number of absorption bays. There was no clear relation between intensity of absorption and duration of a bay. In 1962 nearly every absorption bay at night corresponded to a negative bay in the horizontal component of the geomagnetic field. Seven absorption events observed during the daytime agreed well with the general pattern, suggesting that the same relation exists between these phenomena at night and during the daytime. The ratios of daytime to nighttime values were close to unity. The ratio of the increase in absorption to geomagnetic activity averaged 300 γ/db. (BBB)

11331 PENETRATING RADIATION ENVIRONMENT IN SPACE. Gaines, E. E. (Lockheed Palo Alto Research Lab., Calif.). pp 9-16 of The Effects of the Space Environment on Materials. North Hollywood, Calif., Western Periodicals Co., 1967.

From 11th National Symposium on the Effects of the Space Environment on Materials, St. Louis, Apr. 19–21, 1967. See CONF-670435.

The radiations considered here, those which can penetrate several mg cm^{-2} of matter, appear from various sources both natural and man-made. Charged-particle radiations including high-energy electrons and protons are important from a radiation damage standpoint, while neutrons and photons from natural sources are of less concern because of their relatively small abundance. The spatial distribution of electrons and protons trapped by the earth's magnetic field and the fluxes of charged particles in interplanetary space are discussed along with the energy spectra and time variations of these fluxes in three principal regions, the inner and outer trapping zones of the magnetosphere and the region outside the magnetosphere. In addition, the accumulation of particle flux or dose as a function of time for several particular satellite orbit cases are examined. Among these cases are the synchronous equatorial orbit and low-altitude orbits both polar and low inclination. Particular attention will be paid to these since a large percentage of all satellites have been in low-altitude orbits where the question of orbital lifetime vs. radiation damage lifetime is important and numerous measurements performed by this laboratory provide up to date environmental information. (auth)

11332 VARIATIONS IN Pc 1 FREQUENCY WITH LATITUDE. Heacock, R. R. (Univ. of Alaska, College); Hessler, V. P.; Suchsdorff, C.; Kivinen, M.; Kataja, E. Nature (London), 217: 153-5(Jan. 13, 1968).

Recordings of the magnetic micropulsations (Pc 1) from two auroral zone stations (64.6°N and 63.8°N geomagnetic) and one subauroral station (57.8°N) show a marked latitude variation in midfrequency of structured Pc 1 events, and analysis of data for a 3-month period shows that the average frequency of structured Pc 1 at the lower-latitude station is significantly higher than for the auroral zone stations. There is considerable evidence that structured Pc 1 originate within the magnetosphere on "closed" field lines. The existence of a latitude–frequency relationship is important since some theoretical mechanisms involve ion gyroresonance instabilities, and the ion gyrofrequency increases inwards in the equatorial plane of the magnetosphere. There was a wide spread in frequencies for nighttime occurrences, which suggests that propagation across field lines, north and south from the source lines, may be larger at night, and that a station receives signals from a wider range of latitudes at night. It also suggests that propagation across field lines should be highest in winter months. These suggestions were analytically confirmed, indicating that the latitude spread in Pc 1 frequencies is most reliably studied using daytime and summer data. There are also other possible explanations for the Pc 1 frequency variation than the latitude variation in equatorial proton gyrofrequency, but the results of the present study appear to favor the ion gyroresonance mechanism. (UK)

11333 MEASUREMENTS OF THE EARTH–IONOSPHERIC CAVITY RESONANCE FREQUENCIES AT HIGH LATITUDE. Egeland, Alv; Larsen, Trygve Roed (Univ. of Oslo). Phys. Norv., 2: 85-97(1967).

Earth–ionospheric cavity resonance frequencies were measured by 2 methods differing from those employed previously. Data were recorded, using battery-operated equipment, near Isfjord Radio, Spitzbergen (geographic latitude 78°03.9′ N) and at Lavangsdalen, in northern Norway (geographic latitude 69°15.5′ N) during 1965. Some results are different from low latitude findings. It was possible to record detailed power spectra of the earth–ionosphere cavity resonances by integration over only a few seconds of data. Between dc and 45 cps, peak frequencies at 7.78 ± 0.08, 14.05 ± 0.15, 20.3 ± 0.26, 26.1 ± 0.2, 32.1 ± 0.3, 37.1 ± 0.3, and 42.9 ± 0.4 cps were observed. Also at frequencies above 45 cps there seemed to be clear indications of higher resonance modes. These peak frequencies correspond to a resonance of the entire waveguide system between the earth and the lower ionosphere. Both the peak frequencies and bandwidths (Q values) of this waveguide system can vary significantly during less than 1 min of recording. The slope of each spectrum, the ratios between the power of the different modes, and the superimposed fine structure depend on time of observation, angle of arrival, and observation site as concerns latitude variation, the average intensities of the peaks are markedly lower at Spitzbergen than at Tromsø. The mean diurnal variation in occurrence is closely correlated with the man worldwide thunder storm activity. In addition to these cavity resonances, some other effects of emission bands are described. (BBB)

11334 INITIAL RESULTS OF GEOCORONAL BALMER ALPHA OBSERVATIONS. Tinsley, B. A. (Southwest Center for Advanced Studies, Dallas). Planet. Space Sci., 15: 1757-75 (Nov. 1967).

Observations of Balmer alpha in the night sky from May to November, 1965, have been reduced. After elimination of emissions due to astronomical sources and the effects of the Zodiacal Light, the data were analyzed in several co-ordinate systems. The summer maximum in Balmer alpha intensity seem to be due to the geometry of solar illumination; the nighttime abundances are a little greater in the fall if the effective solar Lyman-β flux

did not increase between summer and fall of 1965. There was no large change in abundance at sunset in the fall, and probably none in the summer. The abundances just before dawn were greater than in the evenings, by up to 30% in the summer. Available radiative transfer models allow only a limited amount of comparison with theory, in which a number of approximations have been made. About 10^{14} atoms/cm^2 of hydrogen above 120 km are called for if a 1962 value for the effective solar Lyman-β flux is used. This abundance agrees with models for lower escape rates in the cooler thermosphere at solar minimum. (auth) (UK)

11335 METHOD OF STUDYING PARAMETERS OF IONIZATION–NEUTRALIZATION AND DYNAMIC PROCESSES IN IONOSPHERIC PARTS WITH INTENSIVE MOTIONS. Serafimov, K. B. (Geophysical Inst., Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 681-4(1967).

An attempt is made to show that methodical possibilities exist for determining ionization and neutralization constants together with the gradient of the vertical velocity of the electronic transport at certain approximations. Three cases are examined in order to determine the balance magnitudes with a negligible contribution of motions: with α and β neutralization and for the about-maximum part of the layers. (J.H.M.)

11336 IONOSPHERIC RADIO WAVE ABSORPTION EVENTS AND THEIR RELATION TO SOLAR PHENOMENA. Basler III, Roy Prentice. College, Alaska, Univ. of Alaska, 1965. 205p. Thesis.

A six-year series of high-latitude radio-wave absorption data is examined in the context of the general subject of solar–terrestrial relations. The data show that the two well-known types of absorption, polar cap absorption (PCA) and auroral absorption, are caused by different types of solar-particle emissions. On the one hand, particle streams which are ejected from the Sun during flares with energies ranging from hundreds of MeV down to a few keV produce great nonrecurring magnetic storms and auroral effects, PCA events, and, in extreme cases, ground level cosmic-ray increases. The typical sequence of events following a flare is the onset of PCA after one or two hours followed by a magnetic storm and auroral activity commencing after one or two days. On the other hand, long-lived streams of particles with energies of only a few keV and attributed to solar M regions give rise to recurring magnetic storms, aurora, and auroral zone radio-wave absorption, but not to PCA or other high energy phenomena. (TSS) (Disser. Abstr.)

11337 ATMOSPHERIC PRESSURE WAVE GENERATED BY A NUCLEAR EXPLOSION. Van Hulsteyn, David Bentley Sr. Ann Arbor, Mich., Univ. of Michigan, 1964. 105p. Thesis.

The problem of describing the atmospheric pressure wave that an observer located on the Earth's surface will detect at a great distance from the source has been investigated in considerable detail during the past twenty years. Previous researchers attempted to describe the phase and group velocities of propagation by postulating atmospheric temperature structures of varying complexity. In the course of such analysis, they were forced to rely upon numerical methods in order to determine the dispersion relations and the corresponding wave solutions. In this presentation the simplified isothermal temperature structure is considered in order to obtain an analytic development of the solution. Using a method presented by Langer, it is determined that there is one stable mode of oscillation, which is referred to as the gravity wave and an infinite number of modes, which arise from Langer's turning point analysis. This latter set, as it develops, are spurious modes which damp out quite rapidly due to the viscous nature of the atmosphere. On this basis one can obtain an excellent approximation to the total solution by considering only the gravity wave contribution. In the analytic development of the solution it is necessary to describe a time-independent Green's function which will make it possible to determine the pressure at the observer's position in terms of the pressure generated by the blast. It is shown that two alternate representations for the Green's function are available. The first of these can be determined as an expansion in spherical harmonics. With this development the time variation of the pressure wave satisfies the causality requirement but converges far too slowly to be useful. The alternate scheme is obtained by a Watson transformation and does converge rapidly. Since this expression is entirely equivalent to the first representation, this form must also yield a causal solution. The description of the explosion is treated by considering a surface S_0 which encloses the source. On this surface the time variation of the pressure is assumed to be known from empirical data, while in the region exterior to S_0 the equations of hydrodynamics can be linearized. The advantage in considering this surface is that it permits the determination of the relation between the energy of the explosion and the amplitude of the theoretical pulse that an observer might expect to detect. The result of the investigation is that the time independent solutions are in excellent agreement with observed data. In fact, it is possible to determine the energy of the explosion very accurately if the height of burst and the distance between the source and the observer are known. (Disser. Abstr.)

Low-Temperature Physics

Refer also to abstracts 10459, 10602, 10649–10651, 10982, 11240, and 11796–11798.

11338 (CEA-Bib-113) PHENOMENES HAUTE FREQUENCE DANS LES JONCTIONS DE JOSEPHSON. (High Frequency Effects in Josephson Junctions). Lasry, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Dec. 1967. 30p. (In French). Dep. Thesis.

A Josephson junction consists of two superconductors separated by a thin insulating layer. When a constant voltage is applied across such a junction, under some conditions, a very high-frequency electromagnetic radiation emanates from the gap, indicating the presence in the gap of a current of frequency $\nu = 2eV_0/h$, called the ac Josephson current. The equations describing this effect are briefly analyzed. Some experiments are then described: first, the experiments which provide indirect evidence for the existence of the ac Josephson effect, starting from the structure of the junction dc current–voltage characteristic, and second, the experiments which provide direct observation of the ac Josephson effect. (auth)

11339 CRYOTRON SUBSTRATE INTERCONNECTION TECHNIQUES. Slade, A. E. (Arthur D. Little, Inc., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-3: 284-5(Sept. 1967).

Experiments were performed to determine if epoxy cement can be used to bond mylar to glass in such a way that superconductive lines can be evaporated over the bond. Similar experiments were performed with glass bonded to glass. It was found that the epoxy bonds were mechanically strong even after repeated immersion in liquid He. To determine if superconductive lines evaporated over an epoxy bond are continuous, a persistent current circuit was constructed; half of the circuit was on one substrate and half on another. A persistent current was established in the combined circuit and all tests gave excellent results. It was also shown that superconductive transformers can be used to couple circuits on different substrates via a window in the ground plane. In these experiments a primary loop was evaporated on a substrate consisting of glass bonded to mylar. At the end of the mylar, the loop passed over a hole in the ground plane. The secondary circuit, constructed on a second mylar-glass substrate, had a matching window. Current transformation efficiencies as high as 94% were obtained. Thin film transformers were constructed having current transformation ratios as high as 26 to 1. These transformers consisted of a number of single turn secondaries connected in parallel and primaries connected in series. (BBB)

11340 THERMODYNAMICAL PROPERTIES OF SUPERCONDUCTING CONTACTS. Fulde, Peter (Institut M. von Laue-P. Langevin, Munich); Moormann, Wichen. Phys. Kondens. Mater., 6: 403-15(Nov. 30, 1967).

The thermodynamic properties of superconducting contacts are investigated and the specific heat in the vicinity of the superconducting transition point is calculated. By considering the thick film limit, it is found that the reduction in the specific heat is a much more delicate measure of the proximity effect than is the change in transition temperature, for example. When the normal film consists of a paramagnetic metal, it can be shown that for superconducting films even as thick as 100 times the coherence distance the reduction in the specific heat is still approximately 15%. The computations apply to arbitrary mean free path. Finally experiments by Shiffman et al. on eutectic Pb–Sn alloys are discussed and it is shown that reasonably good agreement between theory and experiment can be obtained. (auth)

11341 SUPERFLUIDITY OF LOW-DENSITY FERMION SYSTEMS. Fay, D.; Layzer, A. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev. Lett., 20: 187-90(Jan. 29, 1968).

Results are presented concerning the exact low-density behavior of the pairing interactions U for fermions with arbitrarily strong short-range forces. Only the $T = 0$ and $\Delta = 0$ limit of U are considered. (M.O.W.)

11342 SUPERCONDUCTIVITY OF RHENIUM AND SOME RHENIUM–OSMIUM ALLOYS AT HIGH PRESSURE. Chu, C. W.; Smith, T. F.; Gardner, W. E. (Univ. of California, San Diego). Phys. Rev. Lett., 20: 198-201(Jan. 29, 1968).

The pressure dependence of the superconducting transition temperature of single-crystal and polycrystal samples of rhenium and a number of Re–Os alloys was measured. (M.O.W.)

11343 HELIUM CRYOSTAT FOR NEUTRON DIFFRACTION MEASUREMENTS IN THE TEMPERATURE RANGE FROM 3 TO 300°K. Balla, Janos. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 393-9(1967). (In Hungarian).

The system and operation of the variable-temperature helium cryostat, built for neutron-diffraction experiments, are described. Results of experiments to produce temperatures other than 4.2 K°, as well as operational experiences with the cryostat, are reported. (auth)

11344 NUCLEAR MAGNETIC RESONANCE AND SUPERCONDUCTIVITY IN THE CLATHRATE SALT $[Ag_7O_8]^+HF_2^-$. Gossard, A. C.; Hindermann, D. K.; Robin, M. B.; Kuebler, N. A.; Geballe, T. H. (Bell Telephone Labs., Murray Hill, N. J.). J. Amer. Chem. Soc., 89: 7121-3(Dec. 20, 1967).

The 22-G-wide ^{19}F NMR spectrum was observed at 4.2°K in material of nominal composition Ag_7O_8F. In addition, a proton nuclear resonance with 2 satellites was also seen. It is suggested that these spectra are characteristic of the HF_2^- ion, and that preparation of the compound Ag_7O_8F is accompanied by the formation of more or less $Ag_7O_8HF_2$. Dc measurements of the resistivity of multiply twinned "single" crystals of $Ag_7O_8HF_2$ demonstrated a small resistivity anomaly at about 220°K and a large discontinuity at 80 to 100°K, which is most likely associated with the phase change at 80°K. The resistivity of the single-crystal samples at 300°K was 2.3×10^{-2} ohm cm and dropped by a factor of about 30 on cooling to 4.2°K; the crystals became superconducting at 1.0 to 1.5°K. Since Ag^{2+} has the $4d^9$ configuration its presence in any coordination will make $Ag_7O_8HF_2$ paramagnetic; however, measurement of the magnetic susceptibility of $Ag_7O_8HF_2$ in the range of 1.4 to 296°K showed only the temperature-independent Pauli paramagnetism characteristic of a metal lacking local moments. An explanation is made of this phenomenon, and spectulation on the connection between superconductivity and the dynamics of ion motion is made. (D.H.M.)

11345 HIGH-FIELD SUPERCONDUCTORS AT ELEVATED TEMPERATURES. Harper, C. M. (RCA Labs., Camden, N. J.). RCA Eng., 12: 44-7(Dec. 1966–Jan. 1967).

Studies were made on type-II superconductors with high transition temperature ($T_c \geq 9$°K) and large current-carrying capacity in high magnetic fields ($J_c \approx 10^5$ A/cm^2), known as high-field superconductors. They include Nb_3Sn, NbTi, and NbZr. The experiments investigated the temperature and magnetic field dependency of the critical current density J_c and the pinning strength parameter α of these high-field superconductors. Samples of prime interest in this investigation were niobium stannide. The typical magnetization curve for a sample of Nb_3Sn is shown. The Nb_3Sn was vacuum-deposited on hollow ceramic tubes to a thickness of about 80 μm. This superconductor has a transition temperature of 18.2°K and an upper critical field of 220 kOe. The effects of high magnetic fields and elevated temperatures on Nb_3Sn were examined. Although flux jumps are not fully understood, the heat developed by the motion of flux through the superconductor is believed to be a determining factor in causing them. The poor thermal diffusivity of these superconductors at low temperatures causes hot spots to develop before heat can be dissipated, and an avalanche of flux motion results in a flux jump. Experiments with Nb_3Sn revealed that there is an optimum temperature where flux jumps are minimized while J_c is not seriously impaired. A practical critical current density for Nb_3Sn was derived from magnetization curves taken at fixed temperatures from 4.2 to 14.1°K, the range in which flux jumps persist. (BBB)

11346 A LARGE BORE, HIGH-FIELD MODULAR Nb_3Sn MAGNET. Schrader, E. R. (RCA Labs., Harrison, N. J.); Thompson, P. A.; Drautman, J. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-3: 285-6(Sept. 1967).

Design, construction, and preliminary testing of a 15-cm bore, 15-tesla superconductive magnet are described. This magnet was made with optimized Nb_3Sn ribbon conductors, and consists of 22 modules arranged in 5 concentric rows. Each module contains, in addition to the windings, distributed resistive shorts and closely coupled secondary turns. Single turn high-conductivity energy sinks are also utilized between modules as well as at the magnet ends. These dissipative elements attenuate flux motion through the magnet, and provide protection when the magnet is quenched. This results in a quasi-stabilized magnet, having the highest current density consistent with the operating requirements. Numerous diagnostic probes are included within the magnet to aid in operation (to determine local voltages, magnetic fields, time variations of flux, and temperatures). The system includes a 28-in. ID liquid He dewar and an electrical system for energizing the magnet and for monitoring its performance. The magnet is powered by four 100-A low-voltage power supplies, corresponding to four powered sections of the magnet. The power supplies can be remotely programmed or manually operated, and facilities for performance diagnostics and sequence control are included. (BBB)

11347 SUPERCONDUCTING MICROWAVE FILTERS. Markard, E. W.; Perlman, B. S. (RCA Advanced Communications Lab., New York). RCA Eng., 12: 38-43(Dec. 1966–Jan. 1967).

Properties of superconductors are considered in terms of use of superconducting materials in microwave filters. The minimum theoretical filter insertion loss and associated high resonator unloaded Q's (in excess of 10^8) are discussed as functions of the superconducting materials, operating temperature, and individual resonator modes. The maximum power that can be passed through a direct-coupled superconducting filter is analyzed theoretically with respect to the peak fields existing in a superconducting cavity resonator before threshold (i.e., a superconducting-to-normal transition at a critical peak magnetic field, or a breakdown due to a peak electric field). Several experimental cavities were evaluated, and the actual attainable cavity Q's compared with those predicted. (BBB)

11348 SUPERCONDUCTING MICROWAVE DEVICES. Clorfeine, A. S.; Taylor, B. N. (RCA Labs., Princeton, N. J.). RCA Eng., 12: 32-7(Dec. 1966–Jan. 1967).

A review is given on the microwave properties of superconductors, and the use of superconductors in the field of microwave (and millimeter-wave) devices in 2 distinct ways is discussed. First, they have led to a number of new devices which use phenomena peculiar to superconductors. Secondly, their superior characteristics, particularly low loss, permit orders-of-magnitude improvement in conventional devices. The former category includes devices useful for the generation, amplification, and detection of radiation. The improved conventional devices include filters and delay lines. Properties of superconductors pertinent to microwave frequencies and their application to these devices are examined. Superconductors are characterized by ultralow loss factors at frequencies which extend, for some materials, into the far-ir. Thus, the improved performance attainable in devices such as high-selectivity cavities and delay lines is marked. (BBB)

11349 DESIGN FOR A 750-MVA SUPERCONDUCTING POWER CABLE. Rogers, E. C.; Edwards, D. R. Elec. Rev., 181: 348-51(Sept. 8, 1967).

A design study of the technical feasibility of a 3-phase 750-MVA superconducting cable operating at 33 kV was made. Such a cable could provide a direct link between a generating station and a load center. The design was required to meet the following specification: 750 MVA, 3-phase, 33 kV, 13 kA, impulse strength 190 kV phase to earth, fault current 91 kA for 1 sec. Other requirements were for a material having a high critical current per unit width combined with the minimum possible ac loss per unit area, in zero magnetic field and at temperatures near 4.2°K (liquid He). In addition to the electrical requirements, mechanical properties and cost are considered. This combination of requirements for ac cable use restricts the choice of superconductor to Pb and Nb and their alloys. Results of ac loss measurements made on samples of as-rolled Nb foil are shown. Each Nb conductor is of 0.0025-cm thickness and is bonded to, and backed by, a 0.25-cm layer of high-purity Al. An outer duct carries coolant flow in one direction, while 2 inner ducts carry the return flow in the reverse direction. The go-and-return coolant paths are thus thermally isolated from each other. The He-cooled conductor system is surrounded by a liquid N_2-cooled heat shield and insulated from it by a vacuum space. The estimated unit capital cost of £219/MVA km is compared with typical values for conventional systems. (BBB)

11350 FLUX SHUTTLING: NEW METHOD FOR THE NONDESTRUCTIVE READOUT OF SUPERCONDUCTIVE MEMORY CELLS. Sass, Andrew R.; Nagle, Eugene M. (RCA Labs., Princeton, N. J.). IEEE (Inst. Elec. Electron Eng.) Trans. Magnet., MAG-3: 268-71(Sept. 1967).

A new technique for the nondestructive readout (NDRO) of a superconductive memory cell is described. The technique to be presented does not have the technical requirements of earlier methods. The sense of the stored current is read out by a read current but without the need of logic and the I^2R heating during readout is negligible. The sense signal is less than that of the resistance detection method for a given size cell with corresponding metal layer thicknesses; however, calculations and experiments indicate that this is not prohibitive. By increasing thicknesses of certain metal layers, since signals for small cells can be increased to a point where they can be handled by state-of-the-art cryoelectric detection systems presently developed. A description of the technique in comparison to previous NDRO methods as well as experiments on a memory cell which utilizes this new NDRO technique are discussed. The possibility of using this scheme for random access and associative memories is examined. (BBB)

11351 CONTRIBUTION TO THE USE OF SUPERCONDUCTING SHIELDS FOR MAGNETIC FIELD SHAPING. Minet, Roger (Centre National d'Etudes des Telecommunications, Lannion, France); Combet, Henri A.; Le Traon, Jean Y.; Schmouker, Jean. IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-3: 271-6(Sept. 1967).

The low-field diamagnetism of superconductors can be used to design quasi-ideal magnetic circuits, especially for traveling-wave maser (TWM) magnets. An analogical approach to the calculation of the efficiency of such nonideal cylindrical superconducting shields is presented. In most cases, the problem reduces to a 2-dimensional Laplace equation with given boundary conditions. The logarithmic complex potential log (Bx − iBy) was used to obtain the field homogeneity and disorientation. Partially penetrated shields may be replaced by perfect equivalent ones. The analog measurements on conducting paper permit quick iterations of the solution. Various field component measurements were done on TWM magnets using Bi thin-film Hall probes and found to be in good agreement with the analog measurements. (BBB)

11352 USE OF SUPERCONDUCTING COILS AS ENERGY STORAGE ELEMENTS IN PULSED SYSTEM OPERATIONS. Lucas, Edward J.; Stekly, Z. J. J.; Foldes, A.; Milton, Richard D. (Avco Everett Research Lab., Everett, Mass.). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-3: 280-3 (Sept. 1967).

The use of superconducting coils as energy storage elements has been inhibited by their tendency to lose their superconductivity during transient operations. However, the recent development of the stabilized superconductor allows the use of superconductors in pulsed system operations. To demonstrate the feasibility of this approach, 2 coil systems were built and successfully operated. The first system was operated up to a maximum output pulse of ~7000 J, and the second to a maximum output pulse of 60,000 J at 8000 A. The first system made use of an 8.35-mH coil which was charged to a maximum current of 1350 A and discharged into a 2.5-ohm resistive load. This system was then repetitively pulsed at a 10-sec rate for a series of ten 3200-J pulses. The second system made use of a 1.92-mH coil. This system was charged to a maximum current of 8000 A in 3 sec and discharged into a 0.5-ohm resistive load. Both coils were wound with a Cu-stabilized Nb−Zr conductor. (BBB)

11353 PREPARATION OF A STABILIZED Nb_3Sn-BASED SUPERCONDUCTING TAPE BY A DIFFUSION PROCESS. Gavaler, J. R.; Patterson, A.; Autler, S. H. (Westinghouse Research Labs., Pittsburgh). J. Appl. Phys., 39: 91-5(Jan. 1968).

A diffusion process has been developed for the preparation of Nb_3Sn ribbon which can subsequently be stabilized to any desired level. The preparation process is described in detail with emphasis on the effect of reaction time, reaction temperature, and contamination on the critical current of the Nb_3Sn. Under optimum conditions, short samples of the ribbon showed a current density of approx 10^5 A/cm^2 field of 100,000 G. The superconducting ribbon, after the diffusion reaction, is partially stabilized by a thin layer of tin which remains on the surface. To further stabilize the ribbon to any desired level, any desired level, another metal can be bonded to the Nb_3Sn through this layer of tin. A small copper-stabilized test magnet was constructed to determine the degree of degradation occurring when the ribbon is wound into magnet. This magnet was found to have approximately the same current-carrying capacity as short samples of the ribbon. (auth)

11354 MAGNETIZATION MEASUREMENTS ON SUPERCONDUCTING BERYLLIUM ALLOYS. Burton, R. (Univ., Geneva). Helv. Phys. Acta, 40: 1012-22(Dec. 30, 1967).

Measurements upon the compound $Be_{22}Re$ have shown it to possess behavior typical of a type II superconductor with Ginzburg-Landau parameter $\varkappa_0 = 1.4$. The temperature dependence of $\varkappa_1$ is much greater than that suggested by the theories which do not include anisotropic effects. Some microscopic parameters have been deduced in order to describe the superconducting state as fully as possible. Two phase binary alloys and several stoichiometric ternary alloys have yielded some information on flux trapping and flux jumping behavior which have been interpreted in relation to filament and flux pinning effects. (auth)

11355 STRUCTURES FOR THE MEASUREMENT OF HIGH-FREQUENCY PROPERTIES OF POINT-CONTACT JOSEPHSON JUNCTIONS. McCumber, D. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 39: 297-306(Jan. 1968).

Others have demonstrated that superconductor point-contact Josephson junctions interact with electromagnetic fields having free-space wavelengths as short as several hundred microns. To lay a theoretical foundation for more quantitative measurements of junction properties, an analysis of electromagnetic properties of three closed point-contact structures was undertaken and how those structures influence a point-contact junction described by a simple but plausible model was computed. The analysis is in part an exercise in antenna theory; the conductors, superconductors, and dielectrics making up the structure act as an antenna for the intrinsically nonlinear Josephson junction. (auth)

11356 AN AC QUENCH PHENOMENON IN HARD SUPERCONDUCTING WIRES. Finzi, Leo A. (Carnegie Inst. of Tech., Pittsburgh); Grasmehr, Thomas W. IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-3: 277-9(Sept. 1967).

The process leading to the quench of superconductivity in a nonideal type-II superconducting wire carrying an audio-frequency alternating transport current in a normally applied static magnetic field was studied. The quench of superconductivity was found to initiate from particular points of 10-mil-dia Nb−25% Zr wire in repeated tests. A nucleation site was closely bracketed by potential probes, and the voltage response of this segment at currents less than the quench current was studied. Utilizing a limited current density model to describe the ac conduction process, previous voltage response measurements were used to calculate values for the model parameter J_c. The model was extended to include heating effects and a regenerative process that leads to a quench of superconductivity. Quench current predictions based on voltage measurements prior to the quench at a single frequency agreed favorably with measured quench currents over a relatively wide frequency range. (BBB)

11357 SOLUTION OF THE LINEARIZED ENERGY GAP EQUATION FOR NONHOMOGENEOUS SUPERCONDUCTORS. Silvert, V. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 1693-8(Nov. 1967). (In Russian).

Boundary conditions are derived for the generalized energy gap equation in nonhomogeneous superconducting systems. The problem of obtaining an exact solution is discussed and several approximations are compared. (auth)

11358 MEASUREMENTS ON CORBINO DISCS OF TYPE-II SUPERCONDUCTORS. McKinnon, J. B.; Rose-Innes, A. C. (Univ. of Manchester, Eng.). Phys. Lett., 26A: 92-3(Dec. 18, 1967).

Some measurements are reported on specimens of type-II superconductors in the form of "Corbino Discs". It is shown that this is a useful configuration to observe critical currents and flux-flow voltages without the complication of surface superconductivity. (auth)

11359 SUPERCONDUCTIVITY OF STRONTIUM TITANATE. Quattropani, A.; Enz, C. P. (Univ., Geneva). Phys. Lett., 26A: 100-1(Dec. 18, 1967).

The anomalous behavior of the transition temperature of superconducting $SrTiO_3$ as a function of the electron density is explained as a reduction of the phase space available for scattering of the Cooper pairs. (auth)

11360 ON THE "TYPE II SUPERCONDUCTOR" MODEL OF SELF-TRAPPED LASER FILAMENTS. Sarfatt, J. (Univ. of California, San Diego). Phys. Lett., 26A: 88-9(Dec. 18, 1967).

Self-trapped laser filaments are interpreted as the "photon superfluid" analog of the Abrikosov state in type II superconductors. The principle of local gauge invariance is used to derive Landau−Ginzburg equations for the filaments. (auth)

11361 ULTRASONIC INVESTIGATION OF ENERGY GAP ANISOTROPY IN SUPERCONDUCTING MOLYBDENUM. Jones, C. K. (Westinghouse Research Labs., Pittsburgh); Rayne, J. A. Phys. Lett., 26A: 75-6(Dec. 18, 1967).

The attenuation of longitudinal waves propagating along the principal directions in pure molybdenum has been measured in the normal and superconducting states. The observed superconducting energy gap anisotropy is discussed in terms of the Garland model. (auth)

11362 ON PHASE SEPARATION IN FERMI–BOSE MIXTURES. Van Leeuwen, J. M. J.; Cohen, E. G. D. (Rockefeller Univ., New York). Phys. Lett., 26A: 89-90(Dec. 18, 1967).

Phase separation in a Fermi−Bose mixture is investigated on the basis of a hard-sphere model using the hard-sphere diameter as a perturbation parameter. (auth)

11363 HOMOPOLAR GENERATOR FOR PROVIDING HIGH CURRENTS TO STABILIZED SUPERCONDUCTORS. Appleton, A. D. (International Research and Development Co. Ltd., Newcastel-upon-Tyne, Eng.). pp 468-74 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The homopolar generator as a power supply for large magnets employing stabilized superconductors is discussed. The develop-

ment of the copper-superconductor composite strip and cable has created a need for a high current supply of up to several thousands of amperes. The homopolar generator is able to meet all of the requirements for the power supply to a superconducting magnet, and becomes increasingly attractive as the specification is tightened. This machine has been under development at IRD for several years, and a range of designs has been produced for a number of applications. From the outset it was decided not to employ liquid metals, which are often associated with these machines, and a substantial program of research and development has been devoted to the use of solid brushes under the conditions pertaining in homopolar machines. (auth) (UK)

11364 STABILIZATION OF SUPERCONDUCTING MAGNETS. Hancox, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 477-81 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The development of superconducting magnets has reached the stage at which large magnets are being designed, built, and successfully operated. A major obstacle in this development has been the phenomenon of degradation, which is the reduction in apparent current carrying capacity of a superconducting wire when wound into a coil, leading to the unpredictable and unreliable performance of magnets. The object of this review is to examine the causes of such behavior and to discuss some possible ways of stabilizing the performance of superconducting magnets. (auth) (UK)

11365 HEAT TRANSFER TO LIQUID HELIUM FROM BARE AND ENAMELLED WIRES. Jackson, J.; Fruin, A. S. (Mullard Research Labs., Salfords, Eng.). pp 494-5 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

In the design of superconducting coils using stabilized or partially stabilized conductors, the heat, which can be transferred from the surface of the conductor to liquid helium, is of vital importance. In particular, the minimum propagating current I_p of a superconductor normal material composite in liquid helium is given by the equation $I_p^2R = SW$, where R is the normal state resistance, S is the cooling surface area per unit length of the composite, and W is the maximum cooling per unit surface area for a superconductor temperature equal to or less than its critical temperature. Insulated samples achieve greater maximum cooling per unit surface area than do bare samples. Measurements were made of the heat transfer from both bare and insulated wires to liquid helium. The copper alloy manganin was used because its resistance is a linear function of temperature in the helium range, and its high resistivity allows measurements to be made at low currents. It was found that both the peak nucleate boiling flux W_n and the minimum film boiling flux W_f are significantly lower for the bare wire than the insulated wire. The temperature drop across the insulation is a function of insulation thickness and thermal conductivity, and since critical temperature is a function of magnetic field, the maximum cooling achieved on an enamelled composite is a function of magnetic field and insulation thickness. The dependence of cooling on magnetic field was observed. The technique can be used to measure and compare the thermal properties of other types and forms of insulation. (auth) (UK)

11366 IMPREGNATION OF SUPERCONDUCTING COILS TO REDUCE TRAINING. Weil, L. (Centre de Recherches Sur Les Tres Basses Temperatures, Grenoble, France). pp 496 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

In order to improve the stability of superconducting coils, it is advisable to improve the heat transfer inside the winding as well as to the liquid helium bath, and to achieve this it is necessary to use a partially crystalline impregnant instead of the classical vitreous impregnants. For the tests described a suspension of silica grains, of about 0.1-mm diameter, in a standard vacuum grease was chosen. The grease solidifies at liquid helium temperature. This impregnant must be introduced during construction of the coil, layer by layer. If applied carefully, it fills perfectly the gaps between wires, thus contributing to the rigidity of the winding, as well as improving the heat transfer. Some tests were also made using crushed grains of glass in place of silica. The results were in favor of the hypothesis that, because of its better conductivity and because of its high mechanical resistance, the mixture of grease and silica improves the training conditions of the coil. (auth) (UK)

11367 CONTROL OF FLUX JUMPING IN SINTERED Nb_3Sn BY HELIUM FLOW THROUGH THE PORES. Claude, M.-L.; Williams, M. (General Electric Co. Ltd., Wembley, Eng.). pp 497-501 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Porous sintered Nb_3Sn can be fully stabilized against flux jumping by forced flow of liquid coolant through the pores. Flux jumping appears to be directly associated with heat produced during magnetization changes, as removal of this heat suppresses the jumps during such changes. Simple immersion sometimes apparently produces a surprisingly slow penetration of liquid. Liquid must in any case be ejected by gas as heat develops during magnetization changes, and it is possible that a porous sample immersed in still helium experiences flux jumping when a critical amount of gas is generated. If liquid helium is forced through the pores in a continuous stream there should be a reasonable chance of removing gas as it is evolved. In addition the movement of liquid over the internal surface of the superconductor might be expected to improve heat transfer. An experimental study of this proposal is described. (auth) (UK)

11368 LANGE'S CRITERION OF THE ULTIMATE STABILITY OF A SUPERCONDUCTING CYLINDER. Williams, M. (General Electric Co. Ltd., Wembley, Eng.). pp 502-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Lange (Cryogenics, 6: 176(1966)) outlined a new attack on the problem, using classical stability analysis, familiar in mechanics but not in this situation. Essentially, the method is to consider the change, during a small displacement of the system, in the sum of potential and dissipative (e.g., frictional) energies; if the sum falls as a result of the displacement, the system is unstable. The potential energy here is that of the compressed flux trapped within a tube formed of a hard superconductor, and energy is dissipated if flux slips out against the friction of the pinning points. The fundamental idea is attractive in that it deals with macroscopic variables and does not involve arbitrary criteria for the occurrence of a jump. (auth) (UK)

11369 EFFECT OF MECHANICAL LOADING ON COMPOSITE CONDUCTORS. Cornish, D. N. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 507-12 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The tests described indicate that the resistance value of the normal material of a composite conductor increases progressively as the conductor is repeatedly stressed in tension, and that there is a corresponding reduction in the value of the minimum propagating current. The effect tends toward limiting values, whose magnitude is related to the load value and the relative cross-sectional areas of two materials. It is therefore expected that a coil operating near the minimum propagating current, and with large hoop stresses, will show deterioration in performance as it is repeatedly energized. (auth) (UK)

11370 PROPERTIES AND TECHNIQUES OF WINDING OF THE CSF SUPERCONDUCTIVE NIOBIUM–TIN TAPE. Smulkowski, O. (CSF, Puteaux, France). pp 519-23 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Among the known superconducting materials, the Nb_3Sn compound is that which possesses the highest magnetic critical field (Hc_2). The critical current density exhibited by this material is also the highest. These two features make the material the most advantageous for producing high magnetic fields. Unfortunately, this material is the most difficult to prepare among the three superconductors on the market at the present time. Both its hardness and fragility render any transformation into wire totally impossible after fabrication of the basic material. For this reason attempts have been made to form the material on the surface of a tape-like base, in order to achieve suitable conductors. Very thin layers must be deposited, so that conductors remain flexible and windable after all heat treatments are completed. The process described is very simple in its principle. It consists in dipping the niobium in a liquid tin bath to associate the two components. The operation is carried out in vacuum in order to prevent any pollution during thermal treatment. Furthermore, vacuum provides cleaning and outgassing of the support surface. The niobium support has the shape of a thin tape, which may be used in very small thickness, a feature which allows winding of the conductor on small diameters. Superconducting thin layers also withstand

very high current densities. The Nb_3Sn layer is 2 to 3 μ for each side, the thickness of the niobium core being from 6 to 8 μ. After completion of the formation of Nb_3Sn, the tape is copper coated in order to obtain a stabilizing layer. This copper coating may be effected either electrolytically for thin layers or by cladding if a heavy coat of copper is desired. The end product of this process being a tape, the winding technique is different from that of wires or stranded wires. This geometrical shape offers a certain number of advantages, especially in the case of large windings. Application to the construction of a superconductor magnet is discussed. (auth)

11371 MECHANICAL AND ELECTRICAL PROPERTIES OF NONSYMMETRIC COPPER–Nb_3Sn–STAINLESS STEEL COMPOSITE SUPERCONDUCTORS. Benz, M. G.; Coffin, L. F. Jr. (General Electric Co., Schenectady, N. Y.). pp 513-18 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

As superconducting magnets increase in size, field strength and stored energy, it is necessary to develop composite superconductors which meet the combined design requirements of high current density, low normal state resistivity, and ability to withstand high tensile stress. This paper considers a particular type of such a conductor, i.e., a composite of copper, Nb_3Sn and stainless steel. The nonsymmetric case (in a geometric sense) is discussed in detail. (auth) (UK)

11372 TECHNIQUE DEVELOPED TO PRODUCE STRIP CONDUCTOR FOR SUPERCONDUCTING MAGNET. Hopes, R. B.; Fallon, G. R. (Rutherford High Energy Lab., Chilton, Eng.). pp 524-8 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

A 100-kilogauss multisection solenoid for use as a research and testing facility in the Laboratory is currently being manufactured. The coils are arranged in five concentric sections. The three inner sections are wound in layer form using niobium–tin tape and the two outer sections are wound in pancake form using 1000 amp. stabilized strip conductor comprising copper strip carrying heat treated niobium–zirconium wires. The apparatus and method developed to produce the strip conductor required for the pancake coils used in the outer sections of the solenoid are described. (auth) (UK)

11373 LARGE CURRENT INTEGRALLY PROCESSED Nb–Ti ALLOY AND COPPER COMPOSITE CONDUCTOR. Taylor, M. T. (Central Electricity Research Labs., Leatherhead, Eng.). pp 529-32 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

There is an interest in the development of large current superconductor–normal metal composite conductors for possible use in magnets of MHD generators and rotating machinery. For this application the magnet, and hence the conductor, must have a predictable performance and sufficient enthalpy to limit the temperature rise occurring during an emergency shutdown of the magnet. A composite conductor made by cladding the superconductor with copper satisfies these requirements. The superconductor has to be in good electrical and thermal contact with the copper at every point along its length. Such a composite conductor has been developed. The composite is made by integrally co-processing the superconductor with the copper to produce a metallurgical bond. It has the form of filaments of Nb–45 wt % Ti alloy embedded in a copper matrix. The integrally co-processed composite can be formed into conductor having circular, rectangular, or more complicated sections. The number of filaments can be chosen to give the required critical current and the quantity of copper to provide the necessary stability. Such a conductor is being developed for an 80 kG, 30-cm bore solenoid with a stable current of about 1,800 amps. Methods of strengthening the conductor are being explored. (auth) (UK)

11374 A 48kG 10cm BORE SUPERCONDUCTING MAGNET WOUND WITH A RECTANGULAR SECTION HEAVY CURRENT COMPOSITE CONDUCTOR. Maddock, B. J.; Carter, C. N.; Barratt, P. B. (Central Electricity Research Labs., Leatherhead, Eng.). pp 533-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Some details are given of a 10-cm-bore 48-kG solenoid built to demonstrate the use of a heavy current composite conductor and its quantity production. This coil will also provide information needed for the design of a larger solenoid with a bore of about 30 cm and a field of 80 kG. A particular feature of the coil is the provision of sufficient liquid helium cooling passages within the winding for operation in any orientation, e.g., axis vertical or horizontal. (auth) (UK)

11375 A 30 kG ROOM-TEMPERATURE APERTURE SUPERCONDUCTING SOLENOID. Cornish, D. N.; Hoare, F. J.; Kubale, J. C. R.; Whittle, H. R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 537-42 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Most of the large superconducting solenoids constructed to date have been operated submerged in simple cylindrical cryostats. As a result the coil axis has been vertical and experiments have been limited to those which can be performed in liquid helium. For some plasma physics experiments access to the magnet field must be at room temperature. Other possible requirements are that the coils must be located and supported against forces arising from coupling with other magnetic field systems, and that the space occupied by the cryostat should be kept to a minimum. The cryostat described houses a superconducting solenoid, 39 cm O.D. × 29 cm I.D. × 48 cm long, producing a field of 30 kG at midlength (on axis). There is an unobstructed room-temperature horizontal tube (23 cm dia) through the center of the magnet. The winding is supported and located by stainless steel spokes. This cryostat, however, is considerably larger than desirable—66 cm O.D. × 66 cm long—because a liquid nitrogen filled radiation shield was used to provide the necessary thermal insulation. This arrangement was chosen to allow reasonable access to the windings, to simplify manufacture, and because the performance of the cryostat could be predicted fairly accurately. (auth) (UK)

11376 THE SUPERCONDUCTING MAGNET PROGRAMME AT THE RUTHERFORD LABORATORY. Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). pp 543-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The principal types of superconducting magnets required in high-energy physics are summarized. Work relating to small and large split solenoids and rectangular or saddle-shaped coils around a circular of elliptical aperture, is summarized in this paper. Some of the design problems are discussed briefly. All of the applications are at present made more difficult and more costly by the necessity for stabilization with normal metal and cooling channels. Since it appears essential to simplify the construction of superconducting magnets before they can be utilized in large numbers in high-energy physics, interest has intensified in the possibility of producing an intrinsically stable conductor by subdivision into strands of smaller diameter. Several specific magnets are being designed, and the present status of these, together with the supporting research program, is outlined. (auth) (UK)

11377 LARGE SUPERCONDUCTING WINDINGS. Bronca, G.; Krikorian, J.; Pouillange, J. P.; Rappanello, D. (Service d'Entretien et de Developpement des Appareils de Physique, Saclay, France). pp 547-52 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The very fast evolution of superconductor technology, with stabilization the most important point, allows the design and building of coils of large size. Work on 3 medium-size coils and the design of a large 1-meter 40-kG coil are described. (auth) (UK)

11378 DESIGN ASPECTS OF A LARGE SUPERCONDUCTING MAGNET. Appleton, A. D.; Cowhig, T. P.; Caldwell, J. (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). pp 553-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The design of a large-bore superconducting magnet requires the careful optimization of a large number of parameters which are sensitive in varying degrees to each other. Furthermore, it is not sufficient to consider physical parameters without complete awareness of mechanical arrangement and assembly possibilities. The problem of the mechanical forces in superconducting windings both from the point of view of calculations and physical arrangement, with passing references to joints, cooling, and some experimental rigs which are being manufactured at IRD, is discussed.

The problem of supporting the electromagnetic forces acting on windings has become a limiting factor in the design of large high field superconducting magnets. Calculation of these forces is difficult and laborious, but considerable progress has been made by those interested in the problem. It is important to determine whether the performance of the superconductor is degraded by the mechanical stress, although there is no evidence to suggest that such degradation will occur. The mechanical design of the winding must accommodate the stresses, principally the circumferential or hoop stress, provide access for the helium cooling, and allow adequate facilities for joints. The number of joints is determined by the maximum piece weight which the superconductor manufacturer can handle; this is an important consideration and could affect some basic parameters of the winding. (auth) (UK)

11379 CRYOGENIC PROBLEMS OF SUPERCONDUCTING MAGNET SYSTEMS. Colyer, B. (Rutherford High Energy Lab., Chilton, Eng.). pp 624-36 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Some of the problems which face the cryogenic engineer when designing superconducting magnet systems are outlined, and some possible solutions to these problems are discussed. (W.H.K.)

11380 CALCULATION OF THE SURFACE-PARALLEL CRITICAL FIELD FOR CLEAN SUPERCONDUCTING FILMS. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Phys., 209: 219-31(1968).

On the basis of Schöler's theory of boundary conditions for the pair potential in clean superconductors, corrections are obtained to standard results for $H_{c||}$. They are given explicitly both for thin and thick films. The results should be valid for T in the neighborhood of T_c. The thin-film corrections do not vanish even in the limit $T \to T_c$. (auth)

11381 ALTERNATING-CURRENT-INDUCED VOLTAGES IN SUPERCONDUCTING WIRES. Taylor, Henry F. (Rice Univ., Houston, Tex.). Phys. Rev., 165: 517-21(Jan. 10, 1968).

A model introduced by Bean and extended by Kim is applied to predict voltages induced in a superconducting wire carrying low-frequency alternating current. A basic premise of Bean's model is that the magnitude of the local current density, J, is determined by the magnitude of the local magnetic induction, B. The function J(B) is assumed to have the form deduced by Kim from magnetization measurements, $J = \alpha/(B + B_0)$, with α and B_0 treated as adjustable constants. Relations for voltage as a function of current have been derived for ac and for ac plus superimposed dc. Predicted V-versus-I curves are found to agree fairly well with oscilloscope tracings obtained for defect-saturated wires of Nb and various Nb alloys. (auth)

11382 CRITICAL FIELD OF SUPERCONDUCTING ALUMINUM AS A FUNCTION OF PRESSURE AND TEMPERATURE ABOVE 0.3°K. Harris, E. P.; Mapother, D. E. (Univ. of Illinois, Urbana). Phys. Rev., 165: 522-32(Jan. 10, 1968). (NP-16506).

Precise measurements have been made of the critical field of superconducting Al from 0.3°K to T_c, at pressures of 0, 3100, 5400, and 7200 psi. The data are extrapolated to T = 0, yielding the values (at zero pressure) $H_0 = 104.93 \pm 0.2$ G, $\gamma = 1.349 \pm 0.015$ mJ/mole °K^2, and $T_c = 1.1793 \pm 0.003$°K. These values are used to calculate the superconducting electronic entropy and the deviation of the critical-field curve from a parabolic law. The results are compared with previous experimental work and with the Bardeen–Cooper–Schrieffer theory as extended by Clem to include effects of energy-gap anisotropy. The present work gives better agreement with previous calorimetric measurements of the thermodynamic properties of superconducting Al than do earlier published critical-field measurements. The shape of the critical-field curve shows no pressure dependence to within the experimental accuracy. Assuming that the shape of the critical-field curve is entirely independent of pressure, it is found that $d \ln H_0/d \ln V = 19.2 \pm 0.4$, $d \ln T_c/d \ln V = 16.4 \pm 1.1$, and $d \ln\gamma/d \ln V = 6.65 \pm 3$. These results are in fair agreement with earlier $H_c(P,T)$ measurements of Al, although our result for $d \ln\gamma/d \ln V$ is about a factor of 3 larger than has been obtained from thermal expansion measurements. (auth)

11383 SUPERCONDUCTIVITY, SUSCEPTIBILITY, AND SPECIFIC HEAT IN THE NOBLE TRANSITION ELEMENTS AND ALLOYS. I. EXPERIMENTAL RESULTS. Andres, K. (Bell Telephone Lab., Murray Hill, N. J.); Jensen, M. A. Phys. Rev., 165: 533-44(Jan. 10, 1968).

Experimental results of a study of superconductivity and magnetic susceptibility in face-centered-cubic alloys of Ir with Ru, Rh, Pd, Re, Os, and Pt, mostly on the Ir-rich side are presented. The results show that the filling up of the d band first depresses the superconducting transition temperature and then causes the susceptibility to increase rapidly. There is a correlation between these two experimental parameters in that metals with large (exchange-enhanced) susceptibilities are not superconducting above the experimental limit (0.015°K). It is predicted that Pd will not superconduct even at 0°K and that superconductivity in Rh and Pt will occur far below 10^{-3}°K, if at all. (auth)

11384 SUPERCONDUCTIVITY, SUSCEPTIBILITY, AND SPECIFIC HEAT IN THE NOBLE TRANSITION ELEMENTS AND ALLOYS. II. COMPARISON WITH THEORY. Jensen, M. A. (Univ. of Pennsylvania, Philadelphia); Andres, K. Phys. Rev., 165: 545-55(Jan. 10, 1968).

The results of an experimental study of the superconducting transition temperature T_c, the magnetic susceptibility χ, and the electronic specific heat γT in noble transition metals are discussed in terms of the existing theory for the interactions that affect these parameters. Particular attention is paid to the possible presence of virtual ferromagnetic spin fluctuations in these paramagnetic metals, using the recent theory of Berk and Schrieffer. The existing data do not prove that the spin fluctuations are suppressing the superconducting transition temperature; however, this seems to be the most reasonable explanation for the strong correlation between the decreasing T_c and the increasing ratio of χ/γ. Calculated values for the variation of the bare density of states, the phonon interaction, the Coulomb interaction, and the spin susceptibility in these metals are presented. (auth)

11385 SUPERCONDUCTING TRANSITION WIDTH IN PURE GALLIUM SINGLE CRYSTALS. Gregory, William D. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 165: 556-61(Jan. 10, 1968).

The superconducting transition in 99.9999% pure gallium single crystals was investigated. The change in mutual inductance at 23 Hz of a pair of coils containing the sample was used to monitor the transition. In long, thin single crystals, the transition was 90% complete in a temperature interval of 2×10^{-5}°K, a smaller superconducting transition width than is usually reported in the literature. This transition width corresponds to a superconducting penetration depth at 0°K of $\lambda_0 \leq 3.8 \times 10^{-5}$ cm, in agreement with the nuclear-resonance data of Hammond and Knight. Several factors were investigated for possible effects on the transition width. For pure single crystals, the dominant contribution to the transition width was correlated to the relative lengths of the sample and the primary coil. Samples shorter than the primary coil showed substantially broadened transitions, probably caused by a complex nucleation of the superconducting state at the blunt ends of the specimens in the weak (10^{-2} to 10^{-3}-G) primary-coil magnetic field. All effects of damage on the transition width were removed by 40 hr of room-temperature annealing, and the transition temperature from specimen to specimen of cut and annealed specimens was the same to within a temperature interval at least as small as the transition width. These results support the suggestion by Gregory, Sheahen, and Cochran that the critical-field curve of gallium may be used as a reliable secondary temperature standard below T_c = 1.083°K. (auth)

11386 FAR-INFRARED ABSORPTION IN THIN SUPERCONDUCTING LEAD FILMS. Palmer, Leigh Hunt (Univ. of California, Berkeley); Tinkham, M. Phys. Rev., 165: 588-95 (Jan. 10, 1968).

Measurements of the far-infrared conductivity $\sigma_1 - i\sigma_2$ of thin superconducting lead films with resistances of about 200 Ω/square in the normal state are described. The conductivity is inferred from measurements of the transmittance and reflectance of a thin film of lead evaporatively deposited on a quartz crystal. Results are reported for the real part of the conductivity of lead over the frequency range 9 to 120 cm^{-1}. From these an energy gap is inferred for lead films at T = 0 of 22.5 ± 0.5 cm^{-1}, or $(4.5 \pm 0.1)\ kT_c$, where k is the Boltzmann constant and T_c is the superconducting transition temperature. The measurements were made at 2.0, 4.3, and 5.5°K, and the energy gap varies with temperature in the manner predicted by the Bardeen–Cooper–Schrieffer theory. The frequency dependence of the real part of the conductivity also is in good agreement with the theory. No evidence is found of the strong precursor absorption previously reported in the energy gap in lead, but σ_2 is found to be anomalously low (by ~25%) near and below the gap frequency. This is believed to result from the strong-coupling anomalies discussed by Nam. This anomalously low σ_2 would also account for the anomalously steep absorption edge observed in other experiments on lead. (auth)

11387 PROPERTIES OF AN ABRIKOSOV FLUXOID IN TYPE-II SUPERCONDUCTORS. Leadon, R.; Suhl, H. (Univ. of California, San Diego, La Jolla). Phys. Rev., 165: 596-601(Jan. 10, 1968).

An Abrikosov fluxoid in a pure, bulk, type-II superconductor has been studied by the Green's-function technique for superconductors, as developed by Gor'kov. An approximate Green's function has been obtained for the system, and the local densities of states have been evaluated numerically as a function of energy and position in the fluxoid. In agreement with the results of Caroli, de Gennes, and Matricon, the calculated density of states near the Fermi surface is comparable to that of a cylinder of normal metal with radius ξ_0, the coherence distance. The effect of fluxoids on the nuclear spin relaxation rate of a superconductor has been estimated from these results. For fairly high temperatures, the relaxation rate of a superconductor with fluxoids is less than the rate for the same superconductor in zero field, while for very low temperatures, the rate is increased. These trends are in agreement with the experimental data of Silbernagel. (auth)

11388 MAGNETIC FIELD DEPENDENCE OF MILLIMETER-WAVE ABSORPTION IN BULK SUPERCONDUCTING ALUMINUM. Budzinski, Walter Valerian. Pittsburgh, Univ. of Pittsburgh, 1967. 88p.

Thesis.

The effect of a static magnetic field on the absorption of microwaves has been measured for the frequency range 15 to 100 Ge in bulk superconducting samples of pure aluminum and aluminum containing 0.2 at. % silver impurities. Using a calorimetric technique, measurements were made at a low temperature ($T = 0.34\ T_c$) and the absorption was always observed to increase with increasing magnetic field. In pure aluminum, the effect of the field is to spread out the absorption edge associated with the superconducting energy gap. This effect apparently is due to the anisotropic energy increment $\vec{v} \cdot \vec{p}_F$ of the electrons in the surface which take part in the Meissner current shielding the static field from the interior of the superconductor. A simple model for this effect has been used to calculate the expected increase in absorption. In impure aluminum, the spreading of the absorption edge due to the magnetic field is greatly reduced. This is understood as a washing out of the field-induced anisotropy. In the impure aluminum data, a peak in the absorptivity appears at the zero-field energy gap. The origin of this peak is not understood. (Disser. Abstr.)

11389 MICROWAVE PHONON ABSORPTION IN NORMAL AND SUPERCONDUCTING ALUMINUM. Fagen, Edward Allen. Pittsburgh, Univ. of Pittsburgh, 1967. 82p.

Thesis.

Initial measurements are reported on the attenuation of longitudinal ultrasound by pure aluminum over the temperature range from 0.36 to 1.2°K at a frequency of 9.3 GHz. At this frequency the phonon energy, $\hbar\omega$, is no longer negligible compared to the superconducting energy gap, $2\Delta(0)$, and the possibility exists of phonon decay via the excitation of quasi particles across the gap, in addition to the usual quasiparticle scattering process. Data on both a polycrystalline and monocrystalline sample exhibit a discontinuity of the order of 22% of the normal state attenuation, approximately five millidegrees below the transition temperature, T. These results are compared with computations based on the Bardeen–Cooper–Schrieffer theory of superconductivity, and the discontinuity is tentatively attributed to the sudden onset of the gap-jumping process, at temperatures such that $\hbar\omega > 2\Delta(T)$. The remainder of the attenuation curve is shown to be described by the familiar low-frequency result for the scattering process alone, with $2\Delta(0) = (3.4 \pm 0.3)\ kT_c$. (Disser. Abstr.)

11390 SUPERCONDUCTING ISOTOPE EFFECT IN MOLYBDENUM BORIDE AND TUNGSTEN BORIDE. Engelhardt, John Joseph. San Diego, Calif., Univ. of California, 1967. 75p.

Thesis.

The isotope effect on the superconducting transition temperature was measured for the compounds Mo_2B and W_2B. Both the heavy masses and the B mass were varied independently in each compound. The compounds have isomorphous crystal structures with nearly identical lattice parameters. The effect of changing the boron mass appeared to be small in both compounds. The Mo and W isotope effects were much larger. Under the assumption that the Mo_2B lattice was made up of only the Mo mass, the Mo isotope effect was found to be the same as that found in elemental Mo. By considering the W isotope effect in W_2B analogously, the elemental W isotope effect is predicted to be the same as that found in nontransition-element superconductors. The role of the d electrons in Mo and W is discussed in light of these results. (Disser. Abstr.)

11391 AUDIO-FREQUENCY ELECTROMAGNETIC PROPERTIES OF NORMAL AND SUPERCONDUCTING INDIUM. Johnson, Edwin Freeman. Ithaca, N. Y., Cornell Univ., 1967. 159p.

Thesis.

Helicon-like resonances have been observed in the intermediate state of high-purity polycrystalline indium, and an experimental investigation of their properties has been made. The dependence of the resonant amplitudes on the steady magnetic field and the temperature can be understood in terms of helicon theory providing the field-dependent relative permeability is included in the expression for the resonant amplitudes. Furthermore, the "Hall angle" derived by means of helicon expressions has a dependence on the steady magnetic field which is remarkably like that obtained by conventional techniques. In contrast, the "resistivity" and "Hall resistivity" calculated from the helicon expressions cannot be understood by a reasonable model of the intermediate state. More experimentation is needed to clarify this point. As an extension of the studies of the intermediate state, the normal state helicon was investigated in the limit of small steady magnetic fields ($\omega_c\tau \lesssim 1$). The resistivity and Hall coefficient derived from the helicon agree (±15%) with those found by conventional measurements except at the lowest fields ($\omega_c\tau \lesssim 0.5$). The reasons for the discrepancies were not determined. (Disser. Abstr.)

11392 EFFECT OF STRAIN ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF VACUUM DEPOSITED INDIUM FILMS. Reid, William James Jr. Clemson, S. C., Clemson Univ. 1967. 65p.

Thesis.

Thin vacuum-deposited, superconducting films have been stretched and compressed in situ, to which there is no previous reference in the literature. Deposition was upon thin glass substrates, and straining was accomplished by bending these. The computed values of $\partial T_c/\partial p$ for films in tension ranges from −1.2 to −0.15 mdg/atm, becoming less in absolute value with increasing thickness. The computed value of $\partial T_c/\partial p$ for films in compression ranges from 0.32 to −0.053, becoming negative and approaching the accepted value, −0.0436 mdg/atm as thickness increases. Qualitative vindication of previous data showing that the transition temperature of lead decreases as film thickness becomes very small was found. (Disser. Abstr.)

11393 FLUX SPOT INTERACTIONS IN SOLID CYLINDERS OF TYPE-I SUPERCONDUCTORS. Melich, Michael Edward. Houston, Tex., Rice Univ., 1967. 77p.

Thesis.

The Ginzburg–Landau free energy functional is used to investigate the interaction between two collinear normal regions containing flux within an infinite solid cylinder of type-I superconductor. A model of the physical situation is used in constructing a vector potential which is representative of the trapped flux state. The dependence of the free energy on the relative size and separation of the flux spots is presented. The result indicates that there is a stable separation distance of the flux spots which depends upon the amount of trapped flux. When the spots are widely separated they have an attractive interaction between them while for the situation when they nearly overlap they strongly repel. The apparent hard core region is modified when the order parameter is allowed to vary. For a superconductor with a Ginzburg–Landau kappa of 0.2 and a trapped flux of the order 0.1 gauss-cm^2, the equilibrium spacing would be several hundred coherence lengths. These results are used to qualitatively discuss some experiments on the intermediate state and on the trapping of flux in long solid cylinders of molybdenum. (Disser. Abstr.)

11394 CRITICAL FIELD OF SUPERCONDUCTING ALUMINUM AS A FUNCTION OF PRESSURE AND TEMPERATURE ABOVE 0.3°K. Harris, Erik Preston. Urbana, Ill., Univ. of Illinois, 1967. 110p.

Thesis.

The critical field curve of aluminum has been measured from T_c to 0.3°K, at pressures ranging from 0 to 7200 psi. Using calorimetrically derived values for the low-temperature superconducting electronic specific heat, the data have been extrapolated to T = 0, yielding values for H_0 and γ. These values and experimental results for T_c are then used to calculate the superconducting electronic entropy and the deviation of the critical field curve from parabolicity over the entire temperature range. The results show excellent agreement with previous calorimetric measurements of the thermodynamic properties of superconducting aluminum. The shape of the reduced critical field curve shows no pressure dependence over the range of pressures used. The dependence of H_0, T_c, and γ on pressure are in fair agreement with previous work. (Disser. Abstr.)

11395 PROBLEMS IN THE QUANTUM THEORY OF MANY-PARTICLE BOSON SYSTEMS. Lee, Deok Kyo. St. Louis, Washington Univ., 1967. 127p.

Thesis.

The ground state and low excited states of many-particle boson systems are studied. The maximum deviation of the radial distribution function g(r) from its asymptotic value unity is used as a physically meaningful expansion parameter in calculating

the properties of a degenerate boson system. The uniform limit, defined by the condition $|1-g(r)| \ll 1$, holds at low densities under appropriate constraints on the Fourier transforms of the interaction potential and also at high densities for the charged boson system. The explicit analytical formulation of the uniform limit is developed by a variational method based on a Jastrow-type correlated wave function. In the uniform limit the exact connection between the correlation function u(r) and the radial distribution function g(r) is obtained by two different methods: (1) the development of u(r) as a power series in $\alpha \equiv 1-g(0)$ using the exact BBGKY equation in conjunction with the Abe form for the three particle distribution function, and (2) the hypernetted chain summation of cluster integrals. The present study yields a simple derivation of the Bogolyubov formula for the ground state and the excitation energies of a degenerate or nearly degenerate boson gas. Some results going beyond Bogolyubov approximation are also given. The application of the theory to the charged boson system at high densities yields some new and interesting results including $\langle KE \rangle = -\frac{1}{5}\langle PE \rangle$ and $E/N = -0{,}8031/r_s^2 + 0{,}0280$. The constant first-order correction to the leading correlation-energy term is shown to be the best possible within the range of the Jastrow-type trial wave function. Numerical results are also computed at intermediate and moderately low densities ($0.01 \leq r_s \leq 100$). The elementary excitation in liquid ^{4}He are studied using the Brillouin-Wigner perturbation theory. For the four-particle distribution function occurring in the third-order energy correction term, a convolution form is introduced which generates the corresponding convolution form for the three-particle distribution function in the sequential relation. The proposed convolution form proves useful in estimating interaction matrix elements in the elementary process in which the initial and final states each contain two elementary excitations. The numerical evaluation of the elementary-excitation spectrum is carried out using the theoretical radial distribution function obtained by Massey. In the low-momentum region ($k \ll \rho^{\frac{1}{2}}$) it is shown that both the second-and third-order energy corrections are smaller than Feynman's excitation spectrum by a factor quadratic in the wave vector. (Disser. Abstr.)

11396 EXPERIMENTAL SUPERFLUIDITY. Donnelly, R. J. Chicago Lectures in Physics. Chicago, The University of Chicago Press, 1967. 270p.

These notes stem from material presented in a graduate course at the University of Chicago in the winter quarter of 1966. Subjects were chosen that would give the student an elementary introduction to some of the important problems, particularly those related to current research. Emphasis was placed on those aspects of the problems that are of interest to experimental physicists. Topics covered include two-fluid model and macroscopic quantization, quasi-particle model for helium, generalized hydrodynamic equations, microscopic theory of He II, and ions in He II. (W.D.M.)

11397 SUPERCONDUCTING TRANSITIONS OF ISOTOPES OF ZINC. Fassnacht, Robert Earl. Madison, Wis., Univ. of Wisconsin, 1967. 62p.

Thesis.

The effect of isotopic mass on the superconducting transition temperature T_c of Zn has been investigated in three highly purified samples with average isotopic masses of 63.96, 65.91, and 67.94. By extrapolating critical magnetic field curves to zero field, values of 0.856, 0.849, and 0.841°K were obtained for T_c of ^{64}Zn, ^{66}Zn, and ^{68}Zn respectively. These values were found to satisfy the relation $T_c \propto M^{-z} = M^{-0.5(1-\zeta)}$ with z taken as 0.30 and ζ as 0.40. Critical field curves measured between 0.39°K and T_c were found to have a maximum deviation from a parabola of about 5½%. Specific heats calculated from these critical field curves are compared with direct measurements made by others. The superconducting-to-normal transition of a sample was observed to broaden as the applied magnetic field was reduced below some small value. Ratios of transition widths in "zero" field and in the Earth's field ranged from about 2 to over 30 depending on the sample. An appendix contains descriptions and explanations of some of the apparatus used in the course of this work. (Disser. Abstr.)

11398 NUCLEAR SPIN–LATTICE RELAXATION IN SUPERCONDUCTING VANADIUM. Fite II, Warner. New York, Columbia Univ., 1966. 130p.

Thesis.

The nuclear spin–lattice time, T_1 in the superconducting state of vanadium has been measured from the transition temperature, T_c (= 5.225 ± 0.01°K for our sample), to 1.43°K using a field cycling method. The sample consisted of 1 to 2 mm lengths of 0.4-mm-diameter wire with a residual resistivity ratio, Γ, of 15. The sharp drop in T_1 just below T_c exhibited by aluminum and other metals was not found, but the results do not disagree with BCS theory if the effect of flux trapping is considered. As $T \rightarrow 0$, T_1 was found to increase exponentially as expected yielding a value for the energy gap consistent with BCS theory and other measurements. This result disagrees with T_1 measurements in multiple thin films of vanadium made by others. Normal-state T_1 measurements in high field were made to 1.4°K yielding a value of T1T consistent with other measurements made at higher temperatures. The field dependence of T_1 in vanadium was also measured at 5.3°K and found to be given by $T_1(H \rightarrow \infty)/T_1(H) = (H^2 + 3.4h^2)/(H^2 + h^2)$ with h = 80 gauss. (Disser. Abstr.)

11399 RESISTIVE TRANSITIONS AND CRITICAL CURRENT CURVES OF TYPE-II AND TYPE-I SUPERCONDUCTORS. Willis, James Stewart Jr. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 181p.

Thesis.

This research is an extension of earlier work done on the peak effect of the mixed state of type-II superconductors by Schenck, Willis, and Shaw. Attempts have been made to relate various anomalies observed in the resistive transition and critical current curves of superconductors to their critical fields and/or to their inhomogeneity and defect content. The materials studied are mostly alloys of the In–Pb system. Also studied are an alloy of 34.7 at. % Pb in Tl and the type-I superconductors Sn, Pb, and 2 at. % Sn in In. Of special interest is a sample of 13.6 at. % In in Pb which was cast in air. In type-II superconductors, a broad-current-carrying ability above the upper critical field, H_{c2}, is related to the ability of the inhomogeneities of the material to remain superconducting and carry current at fields greater than H_{c2}. The width of this region is related to the difference in the Ginzburg–Landau parameter, $\varkappa$, between the bulk and the inhomogeneities. The rate at which the initial appearance of resistance shifts to higher fields above H_{c2} as the current is decreased is related to the size and form of the inhomogeneities. Finally, it is noted that the transitions at H_{c2} give an indication of the continuity of the entire inhomogeneity system. In type-I superconductors, anomalies in the critical current curves, particularly at fields in the intermediate state range, are related to H_c, H_{c2}, and H_{c3}, and from these a method is developed for determining $\varkappa$ in these materials. The results for Sn and Pb are compared to those few values available in the literature. The mixed state of type-II superconductors is studied and data compared to a theory which is derived on the basis of a change in $\varkappa$ in inhomogeneous regions. Through the energy expression derived by Abrikosov for a type-II superconductor for fields just below and equal to H_{c2}, this change in $\varkappa$ is related to the pinning of flux lines. Such a pinning force is then introduced into the expression for the balance of forces on flux lines in the presence of a transport current. In addition to the pinning term, this includes a Lorentz force term and a viscous drag term. From this it is possible to derive an expression for the critical current curves. This expression is compared to the actual critical current curves and to the temperature dependence of the critical current at H_{c2}. The most significant achievement of the theory is that it offers an explanation of the peak effect. If both H_c and H_{c2} of a pinning center (inhomogeneity) are, at the same time, both greater than or less than H_c and H_{c2} of the bulk, then there is a minimum in the pinning force at the same field where there is a minimum in the critical current curve just before the rise to the peak. Physically, the theory implies that at this field the spot where the flux line is pinned shifts from the inhomogeneity to a location between inhomogeneities. The theory demands, however, that the shift in H_c must be larger than a certain critical value, usually of the order of only two or three oersteds for the In in Pb alloys studied in the temperature rnage from 2.00°K to 4.20°K. Higher values of the change in H_c broaden the peak, while a greater number of pinning centers results in a higher peak. The theory further fits the reduction in the intensity of the peak effect with temperature increase. (Disser. Abstr.)

11400 THERMAL CONDUCTIVITY AND MAGNETIZATION OF TYPE-II SUPERCONDUCTORS IN THE GAPLESS REGION. Soulen, Robert John Jr. New Brunswick, N. J., Rutgers–The State Univ., 1967. 144p.

Thesis.

Thermal conductivity and magnetization measurements were carried out in the same experiment on alloys of indium–bismuth and lead–bismuth over a wide range of the reduced temperature. All specimens had values of the Ginzburg–Landau parameter, κ, greater than 0.707 and thus were type-II superconductors. The emphasis of the experiments was on the magnetic field region near H_{c2} where deGennes and Maki have predicted gapless superconducting behavior for sufficiently short electronic mean free paths (that is, for $l < < \xi_0$). On the basis of this theory, Caroli and Cyrot established a linear relation between the electronic thermal conduction and the magnetization, thus predicting a linear dependence of the electronic thermal conduction on magnetic field. Furthermore, the ratio of the slopes of these two quantities was

shown to be a universal function of the reduced temperature. Since the measured thermal conduction for all the specimens was linear in magnetic field, the ratio of the slopes was calculated and compared with the results of Caroli and Cyrot. Instead of falling on a universal curve, the experimental points displayed a trend with impurity content. The points for the impure specimens were lower than those for the less impure ones, the effect being most prominent in the lead alloys. Qualitatively such a trend can be understood as a relative increase in the phonon contribution to the measured thermal conductivity. The increase in normal electrons as H_{c2} is approached causes the lattice thermal conduction to have a negative slope. Since the lattice contribution to the measured thermal conduction increases with impurity content, the effect of its negative slope is expected to depress the ratio accordingly. The analysis of Maki for the ultrasonic attenuation of transverse phonons in the gapless region was used for a quantitative study of this possibility. When this effect was taken into account, the trend in the indium–bismuth alloys was removed and all points were within 25% of the theoretical curve. However, the trend remained in the lead alloys. The difference in behavior between the indium and lead alloys is most likely associated with how well they satisfy the inequality $l \ll \xi_0$ required by the theory. In the indium–bismuth specimens l/ξ_0 is about 0.1, whereas in the most impure lead–bismuth specimen the ratio is about 1. Measurements by Dubeck on a pure niobium specimen ($l/\xi_0 \simeq 20$) and on an alloy of niobium–oxygen ($l/\xi_0 \simeq 1$) showed the same trend as the lead specimens. (Disser. Abstr.)

11401 SUPERCONDUCTORS. Fleischer, Robert L. (to General Electric Co.). U. S. Patent 3,346,425. Apr. 1, 1964.

A process is given for increasing the critical current density of atomically ordered superconductive metal alloys of the substitutional type comprising subjecting the alloys to a radiation dose of not less than about 5×10^{16} fast neutrons/cm^2 (nvt) to effect partial disordering of the atomic structure of the alloys. (Offic. Gaz.)

11402 REVERSIBLE AND IRREVERSIBLE MAGNETIC PROPERTIES OF SOME TYPE-II ALLOY SUPERCONDUCTORS. Fietz, William Adolf. Ithaca, N. Y., Cornell Univ., 1967. 139p. Thesis.

Magnetization curves of some high-purity niobium-base alloy superconductors were measured using both carefully annealed and heavily cold-worked specimens. The reversible curves of the annealed specimens yielded temperature and electronic mean-free-path dependence of the basic superconducting parameters. The hysteretic curves of the cold-worked specimens gave data on the pinning forces associated with the interaction between the fluxoid lattice and the dislocation structure in the material. The magnetization curves were obtained by electronic integration of the difference between the voltage induced in a coil surrounding a long cylindrical specimen and the voltage induced in an empty coil, as the applied magnetic field was slowly varied. Applied fields up to 49kOe were used and temperature was varied from about 1.2°K up to the transition temperature T_c, around 10°K for all specimens studied. The alloy compositions, up to 50 at. % tantalum and 40 at. % titanium, provided a variation of the Ginzberg–Landau parameter κ from 0.8 up to about 25. In the specimens which were successfully annealed, the ratio of electronic mean-free-path l to coherence length ξ_0 ranged from 0.1 to 15, effectively spanning the region from the dirty limit to the pure limit. For the annealed specimens, the temperature variation and electronic mean-free-path dependence of the parameters κ_1, κ_2, and $h^* = H_{c2}/(-dH_{c2}/dt)_{t=1}$ were obtained. It was found that both κ_1 and κ_2 increased with decreasing temperature but that the magnitude of the increase was 20 to 50% higher than predicted by theory. Experimental values of h^* varied roughly as predicted by theory. The effect of cold working was to enhance the temperature variation of the parameter κ_1. In the cold-worked specimens, the magnetic field and temperature dependence of the critical current density J_c was deduced from the hysteretic magnetization curves. Although the usual critical current relationships were not adequate to describe the behavior over a wide range of magnetic field and temperature, a simple expression for the related volume pinning force F_p was found. This expression is $F_p = CB^n(H_{c2} - B)$ where C is a material constant independent of magnetic field and temperature and n varies from 1 to ½ with increasing field. It was found to describe the behavior of the material over virtually the full range of field and temperature variation to within ±10%. Thermal activation effects appeared to be unimportant in these materials. Regions of instability or flux jumping occurred in the cold-worked specimen when the magnetic field fully penetrated the material and critical current density increased above some threshold value of about 2×10^4 amp/cm^2. This threshold current density was roughly independent of local field and temperature in the specimens. Current theories do not explain the absence of flux jumping on initial field penetration, or the apparently constant current density at the boundary of the region of unstable behavior. (Disser. Abstr.)

11403 IMPROVEMENTS IN OR RELATING TO MAGNET SYSTEMS USING SUPERCONDUCTING WINDINGS. Norris, William Tobias; Chester, Peter Francis (to Central Electricity Generating Board). British Patent 1,099,543. Jan. 17, 1968. Filed Jan. 14, 1965.

A support structure for a superconducting winding in a magnet system is described. It comprises a main support capable of supporting the electromagnetic loads on the winding. It also comprises padding of low thermal conductance arranged between the winding and the main support for transmitting the forces on the winding to the support. This padding comprises sheet material edgewise to the direction of the loads and only occupying a small part of the available space. This provides long narrow thermal conduction paths having low thermal conductance between the winding and the main support. (M.H.R.)

Plasma and Thermonuclear Physics

11404 (LA-3831) STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR 12-MONTH PERIOD ENDING OCTOBER 31, 1967. (Los Alamos Scientific Lab., N. Mex.). Nov. 1967. Contract W-7405-eng-36. 96p. Dep. CFSTI.

The Presidential Supplementary Budget (Fiscal Year 1968) designated the Scyllac project for support. The Joint Committee on Atomic Energy has since approved it for construction. Scyllac support experiments (stabilization) in progress, using Scylla-IV, are reported here and are encouraging. Application of advanced computer techniques to plasma physics seems to be very successful. Since the Los Alamos CTR policy has, for many years, been to study high densities and high temperature, with theory if possible, and without it if necessary, high-β mathematical theory has been a special subject of study; the last two years have seen some progress. The important new factor, however, is the combination of theory and the computer. It seems certain that these techniques will provide results, by means of this new kind of "experimental theory," for regions of density and for systems of complexity that would virtually never be reached by closed mathematical theory. Such computer plasma simulation is not exact either; the computer is still not large enough to handle plasmas exactly, even with poor statistics. So various approximations have to be made, e.g., electrons smeared out, etc. But these approximations may be more valid than those of mathematical theory and moreover they are subject to experimental (i.e., computer) test. This report contains a computer simulation of a θ-pinch which exhibits a loss-cone instability and rapidly relaxes to a stable isotropic configuration. Already this bids fair to solve a long-standing θ-pinch puzzle, namely, that the plasma is able to stream axially out with full thermal speed a short time after the radial compression which added energy only to the radial velocity, and before enough collisions could have occurred to turn the particles from radial to axial motion. In another case, not given in detail here but to be published, the Particle In Cell (P.I.C.) method, which has been so successful in two-dimensional hydrodynamics, has been applied to the hydromagnetic case of the sheath moving down a plasma gun and contracting off the end. The agreements between the computation and the sheath pictures are strikingly close. (TSS)

11405 VYSOKOCHASTOTNYE SVOISTVA PLAZMY. (High-Frequency Properties of Plasma). Sinel'nikov, K. D. (ed.). Fizika Plazmy i Problemy Upravlyaemogo Termoyadernogo Sinteza. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis). Kiev, Naukova Dumka, 1967. 132p.

A separate abstract was prepared for each of twelve papers. (M.O.W.)

For abstracts of individual papers see: 11410, 11417–11419, 11434–11440, and 11478.

Confinement and Heating of Plasma

Refer also to abstract 11475.

11406 (AWRE-O-71/67) THEORETICAL AND EXPERIMENTAL FIELD LIMITATIONS IN CYLINDRICAL FLUX COMPRESSION EXPERIMENTS. Speight, C. S. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec. 1967. 23p. Dep. CFSTI. UK 4s. 0d.

The explosively driven cylindrical imploder has been used in many laboratories to produce very high magnetic fields. Fields of about 5 MG have frequently been obtained by this technique and, in some instances, fields much greater than this have been re-

ported. A simple theoretical analysis is presented which indicates the limitations in field arising from the mechanical and electrical properties of the imploding liner. (auth)

11407 (SU-IPR-202) FURTHER COMPUTER EXPERIMENTS ON ANOMALOUS DIFFUSION. Final Report. Hockney, R. W. (Stanford Univ., Calif. Inst. for Plasma Research). Oct. 1967. Contract AT(04-3)-326. 66p. Dep. CFSTI.

The basic properties of two dimensional particle models were studied and experiments on anomalous diffusion across a magnetic field were performed. The magnitude and correlation of computer noise (random fields arising from computer errors) were measured and agree well with various theoretical estimates. The transport of particles was observed at various magnetic fields and shows a B^{-1} dependence as predicted by Bohm. However, no dependence on temperature was found. Techniques have been developed for using larger time steps in the calculation than previously used, thus enabling longer periods of physical time to be studied. (auth)

11408 (SU-IPR-207) RESEARCH ON ANOMALOUS DIFFUSION AND INSTABILITIES IN INHOMOGENEOUS PLASMAS. Final Report. Thomassen, K. I. (Stanford Univ., Calif. Inst. for Plasma Research). Nov. 1967. Contract AT(04-3)-326. 39p. Dep. CFSTI.

An experiment on anomalous diffusion in the cold-cathode reflex discharge is given, showing the relation between a low-frequency instability and enhanced loss. Also, a general treatment of single-particle transport in random electric and magnetic fields is treated. Finally, an experiment on stabilization of drift waves by an applied random field at the electron cyclotron frequency is explained. (auth)

11409 (UCRL-13257(Rev.1)) STUDY OF MAGNETIC CORES FOR ASTRON PROGRAM. Final Report 6068603. Olson, R. D.; Pavlik, N.; Clark, J. J. (Westinghouse Electric Corp. [Pittsburgh, Pa.]). Dec. 1966. Contract W-7405-eng-48. 43p. Dep. CFSTI.

Control limits are determined for both material properties and processing parameters that will allow satisfactory and reproducible cores to be built. Areas to be investigated include: (1) raw material quality, (2) heat treatment, (3) induced stresses, and (4) interlaminar resistance. (M.O.W.)

11410 PLASMA HEATING BY A FAST MAGNETOSONIC WAVE OF LARGE AMPLITUDE. Chechkin, V. V.; Vasil'ev, M. P.; Grigor'eva, L. I.; Longinov, A. V.; Smerdov, B. I. pp 7-13 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Results are described of an experimental investigation of the heating of a dense plasma by a powerful short-duration high frequency pulse under conditions when a fast magnetosonic wave is excited in the plasma in resonant fashion. The plasma was produced by a pulsed discharge with vibrating electrons in hydrogen or helium at pressures on the order of 10^{-3} mm Hg. The quasi-constant longitudinal field with mirror geometry had a homogeneous section of 80 cm length in its midsection. This field could range from 200 to 6,000 Oe. The high-frequency field was generated with a surge circuit at a frequency 7×10^6 Hz. The results indicate that under resonant conditions such a setup can transfer to the plasma up to 80% of the energy stored in the discharge circuit (3.4 J). This results in a rapid heating (within ~ 1 μsec) of both the electron and the ion components to temperatures 40 to 60 eV, at a plasma density $\sim 10^{14}$ cm^{-3}. Practically all the energy absorbed by the plasma goes to plasma heating. (ATD)

11411 IGNITION OF A HOT PLASMA AT THE SECOND HARMONIC OF THE ELECTRON CYCLOTRON FREQUENCY. Lisitano, G. (Princeton Univ, N. J.). Appl. Phys. Lett., 12: 32-3(Jan. 15, 1968). (MATT-514).

A plasma has been heated to electron temperatures of several hundred eV by concentrating rf power of 60 W, 3 Gc/sec in a plasma volume of 3 cm^3. The heating of the plasma is most efficient at the second harmonic resonances of the electron cyclotron frequency. (auth)

11412 DESIGN AND CONSTRUCTION OF THE CLASP MAGNETIC FIELD SYSTEM. Rowe, R. A.; Sanders, B. C.; Varley, G. L. (United Kingdom Atomic Energy Authority, Abingdon, Eng). pp 176-89 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

CLASP is a toroidal magnetic trap for the study of the confinement of single charged particles in stellarator type field systems. Combinations of circumferential or axial field (B_t), transverse or vertical field (B_v), and the fields produced by opposed toroidally helical (B_L) windings, have been found by computation to produce nested magnetic surfaces which are closed over at least 20 transits of the field lines around the torus. A charged particle would trace out a set of related surfaces, the drift surfaces under these conditions. In the limit as the Larmor radius is reduced the drift surfaces coincide with the magnetic surfaces. CLASP was designed to confirm whether the drift surfaces exist and are closed, after up to 10^6 transits of a charged particle, typical of the containment times which may be required for fusion reactors based on stellarators. Investigation of the surfaces and containment times will be by measurement of the equilibrium population of electrons, produced inside the trap by the decay of tritium gas at 10^{-4} to 10^{-3} torr pressure, requiring a base of 10^{-9} torr in the vacuum system. The design and manufacturing problems of the coils, with their power supplies and cooling systems, are described. (auth) (UK)

11413 TENNIS BALL SEAM COIL FOR PLASMA PHYSICS RESEARCH. Last, J. R.; Skellett, S. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 190-203 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Plasma contained in simple magnetic mirror traps is subject to interchange instability. This instability can be suppressed if the magnetic field rises in all directions from the plasma center, i.e., if the field has a magnetic well. The addition of a transverse cusp field to the simple axial mirror field, to produce a magnetic well, was suggested. For a quadrupole cusp this results in a system of 2 mirror coils and 4 stabilizing coils. It was subsequently shown that these 6 coils could be replaced by a single conductor shaped like the seam on a tennis ball. The shape of the coil and its associated plasma are shown. Advantages and disadvantages of this system are discussed, together with aspects such as choice of parameters, neutral injection, calculation of field, forces and mechanical stresses, and general construction. (UK)

Diagnostics of Plasma

Refer also to abstract 11443.

11414 (LA-3730) FRACTIONAL-FRINGE-SHIFT LASER INTERFEROMETER. Hammel, J. E.; Rode, D. L. (Los Alamos Scientific Lab., N. Mex.). Apr. 25, 1967. Contract W-7405-eng-36. 6p. Dep. CFSTI.

The 3.39-μ radiation from the He–Ne laser was used extensively in the measurement of electron densities in pulsed plasma experiments. The lower limit on density measurements over long paths was of the order of 10^{15} cm^{-2} along the beam. The sensitivity of the method was increased by about one order of magnitude in a singly pulsed plasma where the chamber requires a beam path of many meters. Some of the features of the technique are similar to those used by Hooper and Bekefi in a small repetitively pulsed plasma. A known fractional fringe modulation is applied to the interferometer cavity by a sinusoidal motion of the cavity mirror driven by a speaker coil. The infrared amplitude change due to the fast plasma pulse is then compared with the slow continuous modulation given by the known displacement of the oscillating mirror. The method is checked with a known fast injection of gas. The increased sensitivity is providing information on plasma densities in gun plasma experiments. (auth)

11415 THEORETICAL ASPECTS OF SPECTROSCOPIC DIAGNOSTICS OF PLASMAS. Dominguez, Homero Jimenez (Comision Nacional de Energia Nuclear, Mexico). Rev. Mex. Fix., 16: 123-55(1967). (In Spanish).

The formulas for the absolute intensities and statistical broadening of spectral lines, those for Doppler effect, depression of series limit, continuum intensity of radiation, ionization equilibrium, Inglis–Teller relation, etc., are used in these methods, to get information on the actual conditions prevailing in the system, as well as the experimental values of spectral line widths, intensities and frequencies. (auth)

11416 PLASMA SHEATHS OF MODELS IN HOT-SHOT WIND TUNNELS. Dorey, Jacques; Compard, Didier (Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux, France). IEEE (Inst. Elec. Electron. Eng.) Trans. Aerospace Electron Syst., AES-3: 259-68(Mar. 1967).

Two hot-shot tunnels which produced flows having a Mach number between 15 and 20 were used for testing of plasma diagnostic methods and checking of theoretical data, particularly concerning electron densities and temperatures in a chemically reactive hypersonic flow. Experimental studies showed that an important fraction of the blowdown gave plasma characteristics which were very close to the theoretical ones. The various diagnostic methods

used are discussed, and a study of the nitrogen flow characteristics around models to obtain data which determine the physical state of the plasma are reported. Among the possible techniques, those most adaptable to the special hot-shot conditions, i.e., electrostatic probes and vhf microwave reflectometry, were chosen. The experimental apparatus and results for nitrogen plasma are described. The ionization was not homogeneous during the shot, confirming the assumption that the plasma flow is utilizable only after a delay of more than 10 msec following the shock formation period. (BBB)

11417 COMPARISON OF MICROWAVE METHODS OF PLASMA RESEARCH. Dushin, L. A.; Grigorenko, V. G.; Skibenko, A. I.; Fomin, I. P. pp 95-107 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Experiments aimed at comparing the results of plasma measurements by means of different microwave methods (microwave beam attenuation, microwave interferometry, microwave reflection, and microwave refraction) and with the aid of a double probe are reported. The measurements were made on a plasma situated in a strong magnetic field under conditions when the dimensions of the sounding beam were comparable with or much smaller than the dimensions of the plasma inhomogeneity. The plasma was produced in a discharge tube. The test setup is described. The tests consisted of determining the radial distribution of the density from the refraction of the microwave, determination of the radial distribution of the density from the phase of the reflected waves, determination of the radial distribution from the damping of the microwave signals, and determination of the radial distribution of the density with the aid of a double electric probe. All methods gave comparable results, although there were some angle regions where some methods were more accurate than others. It is concluded that all methods are equally satisfactory. (ATD)

11418 INVESTIGATION OF SPATIAL DISTRIBUTION OF PLASMA DESNITY BY MEASURING THE REFRACTION OF A MICROWAVE BEAM WITH SEVERAL FREQUENCY COMPONENTS. Dushin, L. A.; Kononenko, V. I.; Skibenko, A. I. pp 107-18 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The authors show that the use of several microwave beams with different frequencies or of one beam with several frequency components for plasma diagnostics offers certain advantages, since it makes it possible to determine the density distribution at a fixed angle of incidence and to measure the densities over a wider range. They then present an analysis of the refraction of microwave rays with different frequencies in the plane of the axis of a plasma cylinder and report the results of tests made on a decaying plasma in one cross section, using a microwave beam having three components of wavelengths 2, 4, and 8 mm. An analysis is also presented of the refraction of microwave rays of different frequency in a plane normal to the axis of a plasma cylinder, and the results checked experimentally. The experiments show that the method can be used for both stationary and pulsed plasma. In the case of stationary plasma, it is necessary to locate the receivers for each frequency in positions where the refracted signal has a maximum. In the case of a pulsed plasma, it is necessary to plot the time dependence of the characteristic quantities for each frequency. If several sources operating at different frequencies are used, it is possible to obtain the density distribution with a single discharge. (ATD)

11419 MEASUREMENT OF THE INTENSITY OF HIGH-FREQUENCY STOCHASTIC ELECTRIC FIELDS IN A PLASMA WITH THE AID OF THE STARK EFFECT. Lifshits, E. V. pp 118-30 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

This is a continuation of earlier work (Ukr. Fiz. Zh., 8: 1323 (1963)) where it was shown experimentally that measurements of the intensity of high-frequency electric field excited by external sources in a plasma, and based on the use of the Stark effect in alternating fields, are perfectly reliable. The present paper is devoted to electromagnetic fields which are excited in the plasma during the course of development of various instabilities, and are as a rule superpositions of regular and stochastic oscillations. To this end the author derives relations between the width of the spectral line and the intensity of the electric fields for such fields. In view of the fact that the determination of the shape of spectral line for the Stark effect in alternating stochastic fields is similar to the well-known radiophysics problem of the determination of the frequency spectrum of a signal which is phase-modulated or frequency-modulated by noise. This makes it relatively easy to determine the Stark broadening of the lines. It is shown that the line shape for stochastic fields differ greatly from that for regular fields, and this makes it possible to determine the degree of stochasticity of the high-frequency oscillations from the form of the spectral line. It is thus concluded that the use of the Stark effect in alternating stochastic and regular high- and low-frequency fields is an effective means of diagnostics of an unstable turbulent plasma. (ATD)

11420 IMPROVED MICROWAVE REFRACTION TECHNIQUE FOR MEASURING ELECTRON-DENSITY DISTRIBUTION IN A TRANSIENT PLASMA COLUMN. Shankowski, A. E.; Kharadly, M. Z. (Univ. of British Columbia, Vancouver). Electron. Lett., 3: 335-6(July 1967).

The technique described depends on the multiple reflections of an obliquely incident microwave beam between the plasma critical layer and the walls of the discharge tube. It offers several advantages over previous techniques using microwave refraction; it is simpler and faster to implement, and yields accurate and more reliable results. (auth) (UK)

11421 CHARACTERISTICS OF A REFLEX DISCHARGE IN HYDROGEN IN A MAGNETIC FIELD. Datlov, J.; Musil, J.; Zacek, F. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 18: 75-85(1968).

The properties of an extensive reflex discharge of large power with one heated and one cold cathode in a magnetic field of 10 to 1500 G were measured. At a neutral hydrogen pressure of 10^{-4} to 10^{-3} torr a plasma column was obtained which was 100 cm long, 10 cm in diameter and had a density greater than 10^{-11} cm^{-3}. The dependence of the radial profile of the potential in the plasma was measured by a heated probe, and the temperature and electron density by Langmuir probes calibrated by a microwave interferometer. The dependence of the origin of low-frequency instability on the parameters of the discharge was studied and the measured critical magnetic field was compared with theory. Apart from this low-frequency instability, intensive oscillations were also found in the discharge current in a frequency band up to 30 MHz, and the dependence of their spectrum on the magnetic field was measured. (auth)

11422 MICROWAVE INVESTIGATION OF ACOUSTIC WAVES IN LOW-PRESSURE PLASMA. Sicha, M. (Karlova Univ., Prague); Vesely, V.; Subertova, S.; Seifert, A. Czech. J. Phys., 18: 86-91(1968).

Measurements were made of changes in electron concentration in acoustic waves excited mechanically in a low-pressure slightly ionized plasma by means of a microwave method. The measurements were performed by means of a rectangular resonator in the 3-GHz band. Periodic changes in the rhythm of the acoustic frequency of the electron concentration have been measured. A hypothesis of the origin of the changes in electron concentration has been suggested. (auth)

11423 A 90° LASER SCATTERING EXPERIMENT FOR MEASURING TEMPERATURE AND DENSITY OF IONS AND ELECTRONS IN A COLD DENSE THETA PINCH PLASMA. Roehr, H. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 209: 295-310(1968).

In a 90° scattering experiment performed on a plasma with a density of some 10^{17} cm^{-3} and a temperature of some eV a scattering spectrum is expected which consists essentially of an intense central part and two very weak satellite peaks. In this investigation the spectrum of the central part (ion line) was resolved. From the ion line alone which was in good agreement with calculated spectra, the ion temperature, electron temperature and electron density were determined. At some plasma parameters only a few particles were included in the Debye volume. Also in these cases no deviations from calculated spectra have been observed. In addition the position and half-width of the satellites were measured. The position of the satellites yields an independent value of the electron density which agrees very well with that determined from the ion line. The half-width of the satellites was much broader than expected theoretically due to fluctuations of the electron density within the scattering volume. The measurement was performed on a theta pinch plasma. The energy of the condensor bank was 7.5 kJ, the voltage 18 kV. As a light source a Q-switch laser was used with a power of about 100 MW. Because of beam stops to prevent stray light only a fourth of the whole power reached the plasma. (auth)

11424 TWO-WAVELENGTH INTERFEROMETRY OF A LASER-PRODUCED CARBON PLASMA. David, Charles D, Jr. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Appl. Phys. Lett., 11: 394-6(Dec. 15, 1967).

Experimental determination in a time-resolved manner of the number densities of free electrons and neutral atoms in a carbon plasma is obtained with two-wavelength interferometry. The plasma is produced by a Q-switched ruby laser with a peak power of 100 MW, and a 3-W argon-ion laser is used as the interferometer light source. A maximum free electron density of 1.6×10^{19}

cm^{-3} and a maximum neutral density of 1.6×10^{20} cm^{-3} are observed. (auth)

11425 ELECTROSTATIC PROBE THEORY AND APPLICATION IN A HIGH-TEMPERATURE, COLLISION-DOMINATED, POTASSIUM-SEEDED ARGON PLASMA. McKee, Harris Bonar. Stanford, Calif., Stanford Univ., 1967. 189p.

Thesis.

An analytic examination of the effect of volume ionization and recombination in the vicinity of an electrostatic probe and an experimental investigation using a large cylindrical probe in a high pressure plasma is reported. Previous studies of electrostatic probes have not considered the effects of volume ionization and recombination when the characteristic length for ionization is of the order of the probe size. Experimental measurements have been made in a 2200°K, NaK-seeded, low-velocity argon plasma at atmospheric pressure using a cylindrical probe. The probe characteristics exhibited a strong dependence on the probe temperature which was varied from 350 to 1000°K. For probe temperatures below 500°K the ion saturation currents measured were consistent with predictions of a boundary layer theory. At higher probe temperatures the currents were much larger than predicted by available theories. Although numerous mechanisms have been considered no satisfactory explanation has been obtained for this phenomenon. The electron temperature determined from probe measurements agreed within a rather large experimental uncertainty with temperature predicted by other means. These measurements indicate that the electron temperature is frozen at the free stream value in the boundary layer. The floating potential, that is, the potential with no net current collection was also observed to depend directly on the probe temperature. The magnitude of the floating potential decreased with increasing probe temperature. (TSS) (Diss. Abstr.)

11426 INVESTIGATION OF THE APPLICATION OF LANGMUIR PROBE TO MEASUREMENT IN A FLOWING COLLISIONLESS PLASMA. Iachetta, Fulvio Antonio. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 94p.

Thesis.

The high-velocity plasma employed was produced by passing argon through an ac arc-heated plasma generator and expanding the gas by free jet into a suitable test chamber. The range of conditions included in the experiments are characterized by $T_i/T_e \ll 1$, $r_p/\lambda_D < 0.2$ and $S_0 \leq 3$ where T_i and T_e are the ion and electron temperatures, r_p the probe radius, and S_0 the ratio of ion thermal speed to free stream velocity U_∞. All particle mean free paths lengths were compared to probe diameter. The theoretical basis for the work was the theory of Smetana which predicts probe current as dependent on the particle speed ratio ($S > 1$) for a cylindrical probe placed with its axis normal to the flow. A modification of this theory is included which introduces an effective speed ratio $S' = S_0 \sin\Psi$ where Ψ is the probe angle relative to the plasma stream. Experimental results are presented in the form of probe characteristics determined by measurement correlated with those computed employing Smetana's numerical solutions. Excellent correlation of results with theory was obtained for a probe normal to the flow, ($\Psi = 90°$). The measured increase of ion current for 90° of rotation was found to be 34% compared to a predicted 37%. Results relative to the modification of Smetana's theory were inconclusive though the ion current was found to increase with increasing normal component of velocity. The ion current normalized relative to $\Psi = 0$ as a function of probe angle is compared to a sine function. This comparison indicates the relation to be a modified sine function. Results of this work are compared, insofar as possible, with those of Sonin and agree only in that probe rotation does not affect electron temperature determination. (Diss. Abstr.)

11427 THEORY OF SPHERICAL AND CYLINDRICAL LANGMUIR PROBES IN A COLLISIONLESS, MAXWELLIAN PLASMA AT REST. Laframboise, James Gerald. Toronto, Univ. of Toronto, 1966.

Thesis.

A method has been developed and used to obtain theoretical predictions of the current collected from a collisionless, fully Maxwellian plasma at rest by an electrically conducting Langmuir probe having spherical or cylindrical symmetry. The probe characteristic, or functional relation between current and probe potential, has been determined for both geometries for probe radii up to 100 times the Debye shielding distance of the hotter species of charged particle, for a complete range of ion-to-electron temperature ratios and for probe potentials from −25 to +25 times the thermal energy of the hotter species. Each current collection result is computed to a relative accuracy of 0.002 or better in an average time of approximately two minutes on the IBM 7094. Maxwellian velocity distributions and finite current collection are assumed for both ions and electrons. The infinite plasma is replaced by an outer boundary at a finite radius, beyond which a power-law potential is specified. The resulting nonlinear system of integral equations is solved by an iterative numerical scheme which incorporates an extension of the Bernstein and Rabinowitz method to provide charge densities for ion and electrons. No a priori separation into sheath and quasi-neutral regions is assumed. Explicit comparison is made between the results for a completely Maxwellian plasma and those for a plasma monoenergetic in attracted particles, as treated by Bernstein and Rabinowitz, Lam, and Chen. It is shown that in certain cases, the monoenergetic plasma does not adequately simulate the Maxwellian plasma. It is also shown that difficulties encountered by Bernstein and Rabinowitz in computing the ion current for the cylinder in the zero-ion-temperature limit are illusory, and that the computations of Chen for this case do not take into account the fact that the ion temperature acts as a singular perturbation. Computed charge density and potential functions are presented graphically. Computed probe characteristics are presented in graphical and tabular form. A listing is included of the FORTRAN programs used to obtain these results. (Diss. Abstr.)

11428 ATOMIC DENSITY MEASUREMENTS IN A DECAYING HIGHLY IONIZED HYDROGEN PLASMA. Forman, Peter Russell. Berkeley, Calif., Univ. of California, 1967. 76p.

Thesis.

Atomic-density measurements in a decaying, dense, highly ionized hydrogen plasma have been performed by a vacuum uv-absorption technique. Light of wavelength 890.8 Å is shown through the plasma, and its attenuation, caused by photoionization of the hydrogen atoms present, is measured. The plasma is formed in a copper cylinder 86.4 cm long with a radius of 7.3 cm. In the interior, the initially highly ionized plasma, which has an ion density of 4.9×10^{15} ions/cc and a temperature of about 1 eV, is found to decay by three-body volume recombination. Its atomic density is observed to increase in time at the correct rate, which confirms the earlier notion that this part of the plasma indeed recombines in situ, and remains near Saha equilibrium for up to 200 μsec. During the formation of the plasma apparently a layer of atoms is formed near the cylinder wall. This layer has been detected and observed to relax in a time consistent with diffusion inward due to charge-exchange collisions with the ions of the plasma. The energy loss in the interior regions of this plasma is observed to be at a rate considerably in excess of that expected from normal thermal conductivity or even from anomalous diffusion of ions. (Diss. Abstr.)

Kinetics of Plasma

11429 (CLM-R-75) HIGH FREQUENCY ELECTROSTATIC WAVES IN A NON-UNIFORM PLASMA IN THE PRESENCE OF A MAGNETIC FIELD. Lashmore-Davies, C. N. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug. 1967. 17p. Dep. CFSTI. UK 3s. 0d.

High-frequency electrostatic waves which only propagate in the presence of a density gradient and a magnetic field are described. The analysis is made in cylindrical geometry and both conducting wall and vacuum boundary conditions are considered. When the wave velocity has a component along the steady magnetic field there are two branches of the dispersion relation. The two branches are compared with the two branches of the low-frequency drift waves. Landau damping is shown to be negligible for these high-frequency waves provided the wavelength along the magnetic field is much greater than the Debye length, but collisional damping of the waves is described. Finally, in two appendices, the use of the fluid approximation and the electrostatic approximation is justified. (auth)

11430 (ERL-M-213) EXPERIMENT ON STABLE AND UNSTABLE FLUTE OSCILLATIONS IN A SCALED DOWN MIRROR MACHINE. Chang, T. Y. (California Univ., Berkeley. Electronics Research Lab.). May 24, 1967. Contract AT(11-1)-34. 36p. Dep. CFSTI.

The behavior of flute modes in a mirror machine was studied in a scaled experiment using a potassium plasma generated by surface emission from a centrally located ionizer cathode. The scaling concept and its general application are discussed. Preliminary results of the experiment are also presented. It is found that the plasma is quite reproducible and can be partially expanded away from the ionizer cathode by magnetic decompression. Various flute oscillations were observed and their mode numbers and phase velocities carefully determined. Further improvements in the measurement of both the electric field and the flute growth (or transport) rate are necessary. (auth)

11431 (UCRL-Trans-10202) OSCILLATIONS OF A HOMOGENEOUS ANISOTROPIC LOW-PRESSURE PLASMA. Timofeev, A. V.; Pistunovich, V. I. (Gosudarstvennyi Komitet po Ispol'-

zovaniyu Atomnoi Energii SSSR, Moscow). Translated by J. E. Bradley for Univ. of California Lawrence Radiation Lab., from report IAE-1079. 78p. Dep. CFSTI. JCL $7.60 fs, $2.57 mf.

A survey is presented of theoretical work on the stability of homogeneous anisotropic low-pressure plasma for $\beta = 8\pi p/H^2 \ll 1$. Unstable oscillations are classified in accordance with the physical divergence mechanism. The conditions for instability and the characteristic values of the increments are discussed with reference to an anisotropic Maxwellian distribution with different temperatures along and across the magnetic field and also with reference to a distribution in the form of a δ function. (auth)

11432 SUPPRESSION OF A TWO-STREAM INTERACTION IN A BEAM-PLASMA SYSTEM BY EXTERNAL ac ELECTRIC FIELDS. Obiki, T.; Itatani, R.; Otani, Y. (Kyoto Univ.). Phys. Rev. Lett., 20: 184-7(Jan. 29, 1968).

An experimental study was made of the interactions between ion-acoustic waves excited in a beam-plasma system and externally applied ac electric fields. (M.O.W.)

11433 LOCALIZED (BALLOONING) MODES IN MULTIPOLE CONFIGURATIONS. Coppi, B. (Inst. for Advanced Study, Princeton, N. J. Princeton Univ., N. J.); Rosenbluth, M. N.; Yoshikawa, S. Phys. Rev. Lett., 20: 190-2(Jan. 29, 1968).

A study was made of unstable modes which take place in multipole configurations and are localized along the magnetic field lines. Low pressures ($\beta \ll 1$) are considered. (M.O.W.)

11434 CYCLOTRON RESONANCE IN A COLD ROTATING PLASMA. Dolgopolov, V. V. pp 14-19 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The effect of rotation of a plasma on its high-frequency properties, and particularly on the cyclotron resonance under conditions when the spatial dispersion and short-range collisions between plasma particles can be neglected, is investigated. The plasma rotates whenever it is placed in crossed axial magnetic and radial electric fields. It is shown that the resonant frequency of the rotating plasma differs from the gyrofrequency and that a resonant increase of the radial and azimuthal components of the charged-particle velocity can set in under certain conditions. The absorption of energy from the electromagnetic field by the rotating plasma under resonance conditions is estimated and it is shown that additional conditions must be satisfied at resonance in order for the power absorbed by the plasma to increase. The expression derived for the energy absorbed by unit length of plasma column per unit time under resonant condition agrees with an expression obtained in an earlier paper. (ATD)

11435 CONTRIBUTION TO THE NONLINEAR THEORY OF KOERPER RESONANCE. Shapiro, V. D.; Shevchenko, V. I. pp 27-33 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Nonlinear steady-state waves in a plasma situated in a constant magnetic field are investigated under conditions when the wave propagates transversely to the magnetic field and the thermal motion of the particles can be neglected. Unlike earlier investigations, where only solutions of solitary-pulse type were involved, the present paper considers periodic nonlinear solutions and derives a nonlinear dispersion equation for the dependence of the frequency on the wave amplitude. Such waves are frequently used for plasma production and heating. The dispersion equation is determined from the equations of motion, the continuity equations for the two plasma components, and Maxwell's equations, and its final form consists of three terms, the first of which corresponds to Koerper resonance, the second is a correction connected with the finite damping, and the third term is connected with the nonlinearity of the wave. (ATD)

11436 NON-LINEAR THEORY OF PENETRATION OF ELECTROMAGNETIC WAVE PULSES THROUGH PLASMA BOUNDARY. Tsytovich, V. N.; Shapiro, V. D. pp 34-46 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The importance of boundary effects on the penetration of electromagnetic wave pulses through plasma boundary was studied spectroscopically. As should be expected the length of the narrow spectrum exceeds the beam of the wide spectrum and the accumulated oscillations are considerably more pronounced in the narrow spectrum. The problem of the boundary effects was examined assuming stochastic phases in the transverse and in the generated longitudinal waves. The boundary effects generating the longitudinal waves play an important role in particle acceleration in plasma and in modulating and changing the spectrum of the initial transverse waves. The boundary effects are also important in turbulent plasma diagnostics. (R.V.J.)

11437 SOLITARY PULSE OF LONGITUDINAL WAVE IN A PLASMA. Krasovitskii, V. B. pp 46-9 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

In view of the great usefulness of solitary pulse of electromagnetic energy for focusing purposes, the author analyzes the behavior of solitary ion-sound waves in a cold plasma and shows that under certain conditions a solitary longitudinal wave can exist in a plasma even in the absence of discontinuities in the charge density. The derivation is based on a solution of a system of equations consisting of the hydrodynamic equation of motion and the continuity equations for the plasma particles, the kinetic equation for the particles captured by the pulse, and the Poisson equation. It is shown that this equation has a solution in the form of a pulse propagating with constant phase velocity, and relations are derived for the dependence of the amplitude and phase velocity of the pulse on the density of the particles captured by the wave. It is also shown that in an electron-positron plasma unlike an electron-ion plasma, waves of the type of a solitary pulse with captured electrons can exist. (ATD)

11438 NONLINEAR FOCUSING OF ELECTROMAGNETIC WAVES IN A TOW-LEVEL SYSTEM. Krasovitskii, V. B.; Kurilko, V. I. pp 49-52 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Under the assumption that the wave frequency is fixed, the following nonlinear relationship between the polarization vector P and the electric field E was obtained: $\varkappa \vec{E}$ sign $\Delta = \vec{P}\,[(1/\sqrt{1-p^2}) - (4\pi/3)$ sign $\Delta]$, where $\varkappa \equiv 2Nd^2/\hbar\omega|\Delta|$ is the linear polarization of the medium, $\Delta \equiv \omega^2 - \omega_{res}^2/\omega_{res}^2$, N is density of active molecules, and d is the dipole molecule moment. This relationship shows that at $\Delta < 0$ the polarization vector $\vec{P}$ is a single-valued function of $\vec{E}$. This single valuedness remains at $\Delta > 0$ if $4\pi\varkappa \leq 3$. At $4\pi\varkappa > 3\vec{P}$ becomes a non-single-valued function of $\vec{E}$; as a result of this, the presence of discontinuities in the medium's polarization is possible. (ATD)

11439 KINETIC THEORY OF ELECTROMAGNETIC WAVES IN A BOUNDED MAGNETOACTIVE PLASMA. Kondratenko, A. N. pp 55-74 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

The article deals, in the kinetic approximation, with the propagation of electromagnetic waves in an unbounded layer of plasma situated in a constant external magnetic field parallel to the boundaries of the layer. The investigation is motivated by the fact that the hydrodynamic theory has limited applicability, especially when it comes to an estimate of the wave damping. The constant magnetic field is assumed homogeneous and the plasma boundary is assumed sharp. The problem consists of solving the set of Maxwell's equations and the kinetic equation for a small deviation of the distribution function from equilibrium. In view of the complexity of the resultant dispersion equation, several approximations are considered for the limiting cases of weak spatial dispersion, high-frequency and low-frequency oscillations, surface waves, ion cyclotron waves, and magnetohydrodynamic waves. The results are applicable also to a plasma pinch of round cross section. (ATD)

11440 THE HUYGENS PRINCIPLE IN MAGNETOHYDRODYNAMICS. Polovin, R. V.; Cherkasova, K. P. pp 84-92 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

Huygens principle for magnetohydrodynamic waves in a plasma is defined in a manner that it holds true for any hyperbolic system of partial differential equations. The various rays and surfaces involved in the Huygens principle are also defined. It is shown that the propagation of two- and three-dimensional waves in a plasma, in those cases when magnetohydrodynamics is applicable, yields a number of unexpected effects. First, the subdivision of magnetic sound waves into fast and slow ones becomes meaningless, since all perturbations propagate at the speed of fast magnetic-sound waves. Further, the Huygens principle is not satisfied in magnetohydrodynamics for either two- or three-dimensional waves, since the perturbation differs from zero not only on the wave front but also inside the wave. On the other hand, the Huygens principle is satisfied for one-dimensional magnetic sound waves. In the case of a two-dimensional wave, two voids are produced inside the perturbation region, in which the perturbation is equal to zero. In the case of a three-dimensional wave there are no such voids. When the Alfvén velocity is equal to the speed of sound, conical refraction takes place. This effect can be used for plasma diagnostics. (ATD)

11441 MEASUREMENT OF RF IONIZATION RATES IN HIGH-TEMPERATURE AIR. Taylor, W. C.; Crown, J. B.; Morita, T. (Stanford Research Inst., Menlo Park, Calif.). J. Appl. Phys., 39: 191-4(Jan. 1968).

High-frequency net ionization rates in hot air were determined

as a function of field strength by measurements in a shock tube. The equilibrium air temperature was 3350°K ± 350°. The rates were deduced from time-resolved measurements of the electron density in hot air when exposed to the pulsed fields on microwave slot antennas. The rates in equilibrium hot air were found to be higher than the rates in room-temperature air by more than a factor of ten. The ionization rates are shown to increase from the room-temperature values to the equilibrium hot-air values during the first few mean free paths behind the shock front. (auth)

11442 RADIATION FROM HIGH-PRESSURE PLASMAS. Bauder, U. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Contract AF 33(615)-1915. J. Appl. Phys., 39: 148-52 (Jan. 1968).

If the temperature dependence of the total radiation source strength of a gas are known, the contribution of the line radiation can be determined. The investigation of the line factor L shows that it is independent of pressure over a wide temperature and pressure range. Therefore, to determine the total radiation source strength of a gas at high pressure, one need calculate only the continuum radiation at high pressure and use the measured or calculated line factor of the gas at atmospheric pressure. This method was applied to argon and the total radiation source strength u = F (temperature, pressure), in the range $9000 \leq T \leq 15{,}000°K$ and $1 \leq p \leq 100$ atm was determined using the existing values measured at 1 atm. (auth)

11443 NON-MAXWELLIAN FORM OF THE ELECTRON VELOCITY DISTRIBUTION IN NITROGEN PLASMAS. Noon, J. H.; Blaszuk, P. R.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 39: 9-15(Jan. 1968).

Changes in the form of the electron velocity distribution with time in the active discharge and in the afterglow of a low-energy nitrogen plasma immersed in a magnetic field, have been investigated. A gated microwave radiometer was used to monitor the radiation temperature of the plasma electrons which drops rapidly from 15,000 to 5,000°K following termination of the active discharge. The radiation temperature then remains an order of magnitude higher than that of the neutral gas molecules for a time an order of magnitude greater than the calculated relaxation time of the electron temperature. The magnetic field was swept through a range around the value which produces an electron cyclotron frequency equal to the radiometer frequency. Observation of the radiation temperature as a function of magnetic field strength shows that, for certain values of the discharge parameters, the electron velocity distribution in the active discharge is Maxwellian. In the afterglow, the form of the distribution function is found to change rapidly. (auth)

11444 ELECTRON-TRANSPORT PHENOMENA IN THERMIONIC CONVERTER PLASMAS. Nighan, William L. (United Aircraft Research Labs., East Hartford, Conn.). Contract F1962867C0069. J. Appl. Phys., 39: 223-30(Jan. 1968).

An analysis of electron transport phenomena is developed in a form consistent with conditions known to exist in thermionic converter plasmas. Particular attention is given to the contribution of electron–ion collisions to the electron momentum transfer collision frequency, and the resultant dependence of the plasma transport coefficients on ion density which itself depends upon interelectrode position. Experimentally determined spatial variations of electron density and electron temperature are analyzed numerically for a variety of converter operation conditions and quantitative estimates are made of: the spatial variation of electric field intensity and electrostatic potential in the plasma, the spatial variation of electron kinetic energy flux, and the relative importance of electron energy gain and loss processes in the interelectrode region. On the basis of these results, an interpretation is made of the role played by the cesium neutralization plasma in determining converter performance. (auth)

11445 PRESSURE ANISOTROPY AS A RESULT OF MAGNETIC BREMSSTRAHLUNG. Noerdlinger, Peter D. (Univ. of Iowa, Iowa City). Phys. Rev. Lett., 20: 146-50(Jan. 22, 1968).

In an isotropic distribution of particles undergoing magnetic bremsstrahlung, the particles moving at the largest angles to $\vec{B}$ lose energy the fastest. The resulting pressure anisotropy can lead to plasma instability. The particle velocities tend secularly to align with $\vec{B}$, slightly enhancing the effect. (auth)

11446 COULOMB COLLISIONS OF PARTICLES IN A TURBULENT PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 1789-1805(Nov. 1967). (In Russian).

The effect of Coulomb collisions on the intensity and direction of spectral transfer in a turbulent plasma is considered. A mixed kinetic–hydrodynamic approach is developed which permits the study of those cases when the virtual (difference) waves produced in nonlinear scattering are in the region of frequent collisions. It is shown that in this case Coulomb collisions significantly affect the intensity as well as the direction of the spectral transfer. (auth)

11447 NONLINEAR GENERATION OF HIGHER ELECTRON CYCLOTRON FREQUENCY HARMONICS IN A PLASMA WITH A CURRENT. Livshits, M. A.; Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 1610-21(Nov. 1967). (In Russian).

Nonlinear generation of electron cyclotron harmonics when current instability occurs in a plasma is considered. Nonlinear generation increments are calculated for the ordinary, extraordinary and plasma electron cyclotron waves when ion–acoustic waves are scattered on an electron beam. It is shown that Compton scattering is predominant when ordinary waves are generated whereas nonlinear scattering is predominant when the extraordinary or plasma waves are produced. The possibility of interpreting experiments on generation of electron cyclotron frequencies in a current-carrying plasma by applying the nonlinear excitation theory considered here is discussed. (auth)

11448 MEGAGAUSS IN A Z-PINCH. Bitter, F. (Massachusetts Inst. of Tech., Cambridge). pp 740-1 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The object of the experiments described was to produce very high magnetic pressures by means of a fast z-pinch discharge in a dense metal plasma surrounding a small diameter metal rod. The resulting phenomena are similar to those encountered in exploding wire studies, though the use of such high pressures is probably unique. Peak currents of several million amperes are discharged through a 2- to 4-mm-diameter metal rod, resulting in inward pressures of several hundred thousand atmospheres. If the discharge is sufficiently rapid, the usual instabilities will not have time to develop, so that the dense high pressure plasma column may be studied during a short period. (auth) (UK)

11449 EXPERIMENTAL STUDIES OF THE WING BROADENING OF THE D_δ LINE. Pavlov, M.; Prasad, A. N. (Univ. of Liverpool). Z. Phys., 209: 244-53(1968).

The profiles of the D_δ line from a homogeneous high-density deuterium plasma (electron density $\approx 10^{17}$ cm^{-3}) generated in a T tube, have been investigated over a wavelength range of ±300 Å from the line center. After correcting for the contributions from the underlying continuum and from the adjoining D_γ line, the observed profiles in the main body of the line are in close agreement with the corresponding theoretical Stark profiles. In the line wings, on the other hand, the observed intensities are consistently higher than those predicted by the various asymptotic wing formulae. It is shown that this discrepancy may be resolved and close agreement obtained in all cases with a minor empirical correction to the wing formulas. The corrections resulting from adopting this procedure for the Ly-α line are briefly discussed. (auth)

11450 RECOMBINATION IN COLUMNS. Wilhelm, H. E. (Univ. of Florida, Gainesville). Contract Nonr-580(18). J. Chem. Phys., 47: 4356-65(Dec. 1, 1967).

Gaseous matter is considered, in which an initially inhomogeneous ionization in columns is produced by charged particles. The simultaneous processes of ionization carrier diffusion from, and recombination in, the columns are calculated for a plasma model considering the effects of different electron and ion mobility in the nonisothermal collective diffusion approximation. Analytical solutions of the space and time dependence of the electron and ion density fields and the electric diffusion field are given, as well as the temporal development of the effective column radius, and the critical time τ_H for the ionization to become homogeneous. Based on the dynamics of the individual ionization columns, a macroscopic recombination theory is developed resulting in a quasilinear recombinative plasma decay equation for times $0 \leq t < \tau_H$. The effective columnar recombination coefficient is shown to be considerably larger than the atomic recombination coefficient, $\alpha_N > \alpha$ for $t < \tau_H$, and explicitly time dependent due to the internal dynamics of the system, $\alpha_N \to \alpha$ for $t \to \tau_H$. (auth)

11451 INTERACTIONS BETWEEN HIGH FREQUENCY OSCILLATIONS AND LOW FREQUENCY OSCILLATIONS IN BEAM–PLASMA SYSTEM. Kawabe, Takaya (Nagoya Univ., Japan); Kawai, Yoshinobu; Takayama, Kazuo; Kojima, Shoji. J. Phys. Soc. Jap., 23: 1430-1(Dec. 1967).

The oscillations induced by a 400-eV electron beam in a plasma in the TP-Q device are studied. Frequency spectra are given. (M.O.W.)

11452 PARAMETRIC EXCITATION OF UPPER AND LOWER HYBRID MODES. Amano, Tsuneo; Okamoto, Masao (Kyoto Univ.). J. Phys. Soc. Jap., 23: 1432-3(Dec. 1967).

A general dispersion relation governing the electrostatic waves which propagate perpendicular to the direction of the magnetic field is obtained. The dispersion relation is analyzed in detail in the case of a cold plasma including collisional damping. It is found that a strong interaction is induced between the upper and lower hybrid modes and the coupled modes become unstable if the intensity of the external electric field exceeds some critical value. (M.O.W.)

11453 NON-LINEAR EFFECTS IN TRANSVERSE WAVE PROPAGATION IN HOMOGENEOUS UNRESTRICTED PLASMA. Chakraborti, B. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 3-13(July-Aug. 1967). (In Russian).

A Vlasov equation for elliptically polarized electromagnetic waves propagating in unrestricted homogeneous plasma was resolved by a method of consecutive approximations. (R.V.J.)

11454 OBSERVATION OF SPATIAL ION-WAVE ECHOES. Ikezi, H.; Takahashi, N. (Nagoya Univ., Japan). Phys. Rev. Lett., 20: 140-2(Jan. 22, 1968).

Preliminary results are reported from experiments on the spatial ion-wave echo predicted by Gould et al. [Phys. Rev. Lett., 19: 219 (1967)]. The maximum amplitude of the echo was found to be about 0.1 of the maximum amplitude of the exciting ion waves with frequencies f_1 and f_2. The growing length of the echo was proportional to f_1^{-1} for a fixed value of $f_2 - f_1$. The wavelength of the echo was the same as that of the usual ion wave of the same frequency $(f_2 - f_1)$. The amplitude of the echo decayed according to the Landau damping of the ion wave whose frequency is $f_2 - f_1$. (A.G.W.)

11455 VARIATIONAL CALCULATION OF THE RUNAWAY CRITICAL FIELD IN A TWO-COMPONENT PLASMA. Sels, Ph. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg., 53: 482-500(1967). (In French).

The variational method of local potential, recently extended to statistical mechanical equations by Prigogine and Nicolis (Non-equilibrium Thermodynamics, Variational Techniques and Stability, University of Chicago Press (1965)), is utilized for derivation of a stability criterion for a dilute homogeneous plasma subjected to an external force. The runaway critical field of the electrons is explicitly obtained for a two-component Lorentz plasma located in a constant external electric field, and results are compared with those obtained by other methods. (tr-auth)

11456 HEAT TRANSFER OF A PLASMA JET FLOWING IN A CYLINDER. Stel'makh, G. P.; Chesnokov, N. A. Inzh.-Fiz. Zh., 12: 718-21(June 1967). (In Russian).

Heat transfer was studied experimentally when a plasma jet flowed to the cylinder walls. It is shown that heat transfer intensity from a plasma jet to the cylinder walls is similar to that for a gas jet. (auth)

11457 SMALL OSCILLATIONS IN THE ISOTHERMAL, INHOMOGENEOUSLY COMPRESSIBLE GRAVITATING MEDIUM OF CYLINDRICAL SYMMETRY. Oganesyan, R. S. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 266-73(1967). (In Russian).

It is considered the small oscillations in the isothermal self-gravitating medium of cylindrical symmetry taking into account the compressibility and the inhomogeneity of the density distribution in the equilibrium state using the linear system of hydrodynamic equations. It is obtained the spectrum of the frequencies, and it is shown the approximate region of the change of the critical wavelength. (auth)

11458 PLASMA BETWEEN CONCENTRIC SPHERICAL ELECTRODES. Resikyan, A. M. (Inst. of Radiophysics and Electronics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 2: 233-7(1967). (In Russian).

Low ionization degree gas between the concentric spherical electrodes is considered. The radial distribution of the electrical field and of the charge density is calculated. The distortion degree of plasma is also calculated by means of the Langmuir spherical sound. (auth)

11459 PLASMA WAVES BY BEAM-PLASMA INTERACTION. Stainov, G. Z.; Martinov, N. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 673-5(1967).

Solutions were obtained for the dispersion equation for plane monochromatic waves in an infinite homogeneous plasma located in the outer electrical fields at states close to equilibrium. (M.O.W.)

11460 PLASMA SHEETS IN CURVED ELECTRODE NOZZLES. Guman, William J. (Fairchild Hiller Corp., Farmingdale, N. Y.). J. Spacecraft Rockets, 4: 1668-9(Dec. 1967).

Models for studying the usefulness of curved electrode nozzles for magnetically accelerating plasma in a pulsed plasma thruster are discussed. (M.O.W.)

11461 TRANSITION TO INSTABILITY IN A NONEQUILIBRIUM PLASMA. Coleman, James Thomas. Philadelphia, Temple Univ., 1967. 120p.

Thesis.

Plasma theory predicts the existence of a marginal stability boundary for spontaneous generation of ion acoustic waves. For the case of a drifted Maxwellian electron velocity distribution and a coexisting Maxwellian ion velocity distribution, a critical drift velocity exists beyond which these waves are spontaneously generated. The growth and decay of the plasma acoustic waves was demonstrated by the measured longitudinal electric field fluctuation using floating double probes. Enhanced microwave radiation was observed when the growing plasma waves were generated. The approximate form of the structure factor was determined from the microwave scatter spectrum and also the critical wave number was indirectly measured. A magnetoactive gaseous plasma was generated in the laboratory under carefully controlled conditions. Microwave energy conducted by waveguide illuminated the plasma column and the forward scattered energy was detected. Good agreement was found with the theoretical prediction of the enhanced scattering cross section and with the observed effects of crossing the marginal stability boundary. However, the value of the measured critical wave number indicated poor agreement with the theoretical prediction of the effect of collision on the boundary, when a relaxation term approximation was used. The agreement between experiment and theory shows significant improvement when a more realistic representation is used for the collision term in the Boltzmann transport equation. (Disser. Abstr.) (TSS)

11462 FLOW OF A RAREFIED PLASMA PAST A SPHERE. Prager, David Jehiel. Stanford, Calif., Stanford Univ., 1967. 129p.

Thesis.

The problem of determining the macroscopic flow variables and the electric potential distribution about a sphere is formulated within the framework of the Vlasov equation. Steady-state conditions are assumed and magnetic effects neglected. Approximate solutions for the distribution functions of the electrons, ions, and neutral particles are obtained by exploiting the feature that the characteristics of Vlasov's equation are the particle trajectories in phase space, and the distribution function is constant along a characteristic. Approximate expressions are obtained for the potential, drag, energy transfer, and slip velocity as a function of the ion speed ratio and surface potential. Approximations for the ion and electron number densities in the flow field are determined which are valid for large ion and small electron speed ratios, respectively. These results are used to obtain numerical solutions for Poisson's equation for the potential field by a relaxation procedure amenable to quasi- or semi-linear partial differential equations. Because of the inclusion of thermal motion and the absorption effect of the body, a finite wake is obtained. From the numerically determined potential distribution, an alternative determination of the drag is obtained by calculation of the axial momentum flux of a cold plasma traversing the potential field. A discussion of the drag is made by comparing the numerically computed drag, obtained under various assumptions, with the analytically determined drag. In addition, comparison is made with available experimental data. It is found that the analytical formula agrees well with the experimental drag for small values of the ratio of Debye length to sphere radius. (Disser. Abstr.)

11463 THEORETICAL AND EXPERIMENTAL STUDY OF A SURFACE WAVE ON A TEMPERATE COLLISIONAL PLASMA COLUMN. Kolettis, Nicholas John. Cleveland, Case Inst. of Tech., 1966. 139p.

Thesis.

The axisymmetric TM (Transverse Magnetic) surface wave mode, excited by a magnetic current source and propagated on a uniform temperate plasma column with collisions, is analyzed. Numerical solutions of the determinantal equation for the sourceless problem are presented in the form of "βa vs f" and "αa vs f" dispersion curves, with "β" and "α" the propagation and attenuation factors of the mode, respectively, "a" the column radius and "f" the applied frequency. A most prominent characteristic of these solutions is the strong dependence of α upon "ν," the effective collision frequency for momentum transfer between electrons and neutrals. Temperature effects play a secondary overall role. The theory has been implemented by an experiment performed on a low pressure (4 to 600 μ Hg) dc argon discharge (20 to 400 mA) in a thin-walled glass tube, coupled with a Fabry–Perot type resonator of adjustable length. Experimental β's and α's for the mode were first determined

from recorded standing wave patterns inside the resonator, over the frequency range of 40 to 1100 Mc. The data were then used in conjunction with the theory as a diagnostic tool, to estimate an average electron density and an effective collision frequency in the discharge, at a given pressure and current. (Disser. Abstr.)

11464 NORMAL MODES OF A GYROPLASMA FILLED BEAM WAVEGUIDE. Schaedla, William Hugh. Madison, Wis., Univ. of Wisconsin, 1966. 125p.

Thesis.

The modes of a longitudinally magnetized, plasma filled Fabry–Perot device are considered. Two methods of solution are presented. The first of these transforms the problem into rotating coordinates and utilizes the techniques of Goubau and Schwering. In the second, a Huygen's principle for circularly polarized waves propagating along the axis of rotational symmetry of the medium is derived. This is accomplished using Fourier analysis and integration by the method of stationary phase. An integral eigenvalue problem is then formulated using this Huygen's principle. Circularly polarized modes similar to the linearly polarized modes of an isotropic-medium-filled Fabry–Perot device are found when the device is filled with a gyromedium. The gyromedium-filled device can be considered equivalent to some isotopic-medium-filled device for the calculation of diffraction loss and mode structure. Slow waves exist in a gyroplasma filled Fabry–Perot device near cyclotron resonances, but such modes are inherently lossy. (TSS) (Diss. Abstr.)

11465 ELECTRON DISTRIBUTION FUNCTION IN A NON-EQUIPARTITION PLASMA. Viegas, John Robert. Stanford, Calif., Stanford Univ., 1967. 103p.

Thesis.

Solutions to the kinetic equation of a steady, homogeneous plasma of arbitrary degree of ionization subjected to strong electric fields are developed. Nonelastic as well as elastic encounters are included in the analysis. Expressions for the current density, electrical conductivity and electron temperature of the plasma are also presented. Numerical results are illustrated for the case when the nonelastic effects are neglected. Calculations are presented showing the transition of the isotropic part f^0 of the distribution function from a gas-temperature Maxwellian at near equilibrium conditions to an electron-temperature Maxwellian under nonequipartition conditions. It was found that whenever the electron–electron to electron–neutral collision-frequency ratio was much greater than the electron-to-heavy-particle mass ratio, f^0 is Maxwellian. When f^0 is Maxwellian, the Chapman-Enskog and Spitzer–Härm conductivity expressions developed for the case of weak electric fields are shown to be applicable for strong electric fields providing that in these expressions the electron temperature replaces the gas temperature. An approximate form for f^0 suggested by Ginzburg is compared with the exact expression. The accuracy of the use of a Maxwellian rather than the nonequilibrium distribution function in the calculation of the electrical conductivity is assessed. (Diss. Abstr.)

11466 DYNAMICS OF ONE-DIMENSIONAL PLASMAS INCLUDING SHORT RANGE INTERACTIONS. Flores, Luis Mario. College Station, Tex., Texas A and M Univ., 1967. 61p.

Thesis.

Single species, one-dimensional plasma models suffer from the fact that there is no mechanism to relax the distribution function without taking into account triple correlations. An attempt has been made to provide such a mechanism by introducing short-range interactions between the particles of the plasma. It may be noted that one-dimensional two body collisions do not affect the distribution function because of energy–momentum conservation. Three-body collisions are not subject to such a restriction and a one-dimensional three-body interaction is solvable in principle by reducing the problem to a two-dimensional system with a fixed force. The Fokker–Planck coefficients have been found for a model which consists of an electron plasma, infinitely heavy ions, and square-well forces between the electrons. Properties such as the electron–electron autocorrelation function for the plasma at equilibrium and the relaxation of the distribution function have been investigated. Theoretical results have been compared with those of a computer simulation of the model using a total of 300 particles. A very good agreement has been obtained for the plasma with the short-range interactions in spite of the limited number of particles used. (Diss. Abstr.)

11467 QUANTUM MECHANICAL TREATMENT OF STATIC TRANSPORT PHENOMENA IN NONDEGENERATE PLASMAS. Williams, Robert Howell. Berkeley, Calif., Univ. of California, 1967. 231p.

Thesis.

A convergent kinetic equation for a nondegenerate electron gas is derived from the quantum mechanical BBGKY hierarchy for the Wigner distribution functions. A technique due to Guernsey is generalized to quantum mechanics. When the two-particle interaction is split into a strong, short-range part plus a weak long-range part, a Boltzmann-like kinetic equation is obtained in which the cross section is a sum of three terms: an exact binary collision cross section for the short-range part of the interaction, plus a Born approximation cross section for the dynamically screened long-range part of the interaction, plus a cross correlation cross section evaluated in the Born approximation. In the cross-correlation term the effects of the long- and short-range parts of the interaction are mixed. When the limit $\hbar \to 0$ is taken, the classical convergent kinetic equation of Guernsey is not obtained, since Guernsey did not consider the cross-correlation terms. After the kinetic equation is generalized to a fully ionized plasma, the kinetic equations are solved using the Chapman–Enskog technique. General expressions are obtained for the static transport coefficients in terms of the Chapman–Cowling bracket expressions. Among the quantities evaluated are the transport cross sections for the short-range part of the interaction. These are evaluated using a phase-shift analysis. Exchange effects are also considered. Since no ad hoc cutoffs are necessary using this convergent kinetic equation, the bracket expressions are accurate through first order in the plasma parameter. Both dominant (logarithmic) and subdominant (nonlogarithmic) contributions to the bracket expressions are given correctly for all nonrelativistic temperatures such that the plasma is both fully ionized and nondegenerate. (Disser. Abstr.)

11468 NELINEINYE EFFEKTY V PLAZME. (Nonlinear Effects in Plasma). Tsytovich, V. N. Moscow, Izdatel'stvo Nauka, 1967. 287p.

Nonlinear effects in plasma physics and plasma nonlinearity classifications are discussed in the first chapter. Cold plasma, weak nonlinearities, and nonlinearities of the three-package wave interactions are studied in the second and third chapters. Induced plasma processes, decay and conservation processes, emission and scattering of waves induced by plasma particles, and scattering of electromagnetic waves in isotropic plasma are covered in the next 8 chapters. The stabilization of beam instabilities induced by Langmuir wave scattering, and stability of relativistic beams in relation to the generation of Langmuir waves are discussed. (R.V.J.)

11469 INTERACTION OF ELECTROMAGNETIC WAVES WITH QUANTUM AND CLASSICAL PLASMAS: CORRELATION EFFECT. Nguyen, Dong Quang. Ann Arbor, Mich., Univ. of Michigan, 1964. 120p.

Thesis.

A quantum statistical approach is used to study the interaction of EM waves with a plasma. The quantum calculation is set up to include the correlation effect and is done in a systematic manner using the diagrammatic technique. Here, the Coulomb interaction between charged particles is renormalized so as to take care of the collective effect. This renormalization also reduces the number of diagrams to be considered for any desired accuracy and the correlation effect in a quantum plasma can be accounted for to a high degree of accuracy by retaining only the first few diagrams. The method makes use of a large number of current ideas and techniques including the notion of the response of the plasma to external excitation and its relationship to the transport properties of plasma, the consideration of quantum statistical averages, and the technique of diagrammatic calculation. In the damping of EM waves, it is shown that the contribution to the damping coefficient arising from correlations is more important at the limits of high and low frequencies than the Landau contribution which prevails at plasma resonances. Furthermore, the appearance of the ion Doppler spread instead of the electron Doppler spread in the data for the scattering of EM waves observed in the ionosphere back scattering experiments is explained in terms of the correlation effect. (Disser. Abstr.)

11470 QUANTUM MECHANICAL STUDY OF THE ELECTRON GAS VIA THE TEST PARTICLE METHOD. Rensink, Marvin Edward. Los Angeles, Univ. of California, 1967. 104p.

Thesis.

The electron gas is described in terms of quantum mechanical one- and two-particle distribution functions. The random phase approximation can be used to calculate the two-particle distribution for a homogeneous electron gas as a functional of the one-particle distribution. It is shown that the random phase approximation yields the lowest order term in an expansion in powers of q_{TF}/p_F or $\lambda\!\!\!^{-}/L_D$ where q_{TF} is the Thomas–Fermi wave number, p_F is the Fermi wave number, $\lambda\!\!\!^{-}$ is the thermal wavelength, and L_D is the Debye wavelength. A straightforward calculation of the two-particle distribution function is quite complex even within the framework of the random-phase approximation. However, some of the mathematics involved can be simplified by using a "test particle" approach. It is shown that the "dressed test particle"

concept introduced by Rostoker for classical plasmas can also be applied to quantum mechanical systems. In particular, the two-particle distribution function for an electron gas can be calculated on the assumption that the system is composed of noninteracting dressed electrons. The explicit form of the system response to a test particle is examined for a degenerate (high-density, low-temperature) electron gas. Attention is focused on the quantum mechanical Friedel oscillations in the induced charge density as a function of distance from the test particle. For noninteracting electrons at zero temperature, this contribution to the induced charge density around a stationary test particle is of the form r^{-3} cos $2p_F r$. This investigation includes several factors which might influence the system response: (a) the form of the perturbing test particle potential, (b) the Coulomb interaction between electrons, (c) finite temperature, (d) the test particle velocity, and (e) external magnetic fields. A strong uniform magnetic field has a particularly striking effect on the Friedel oscillations in a direction perpendicular to the field lines. The induced charge in this case exhibits only a finite number of oscillations and then falls off monotonically. The number of complete oscillations corresponds to the number of Landau levels occupied by the electrons. (Disser. Abstr.)

Production of Plasma

11471 (NYO-3578-4) PRODUCTION OF PLASMAS FOR THERMONUCLEAR RESEARCH BY LASER BEAM IRRADIATION OF SOLID PARTICLES. Annual Review, Quarterly Report, June 29, 1965–June 28, 1966. Haught, Alan F.; Polk, Donald H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). July 28, 1966. Contract AT(30-1)-3578. 70p. (UARL-E-920365-4). Dep. CFSTI.

The results obtained with laser-irradiated single-particle plasmas are summarized and the properties of these plasmas are compared with other types of laser-produced plasmas. Two models of the formation and expansion of laser-irradiated solid-particle plasmas are discussed: the first, a hydrodynamic model which provides a detailed picture of the density, velocity, and temperature distribution within the plasma, and the second, a simplified model which displays the major features of the plasma time history and is particularly convenient for calculating the effects of the various experimental parameters on the plasma energy. The apparatus used for the experimental studies is described. Experimental studies of the density distribution, spherical symmetry, velocity profile, and energy of plasmas produced by laser-beam irradiation of single 10- to 20-μ-diameter solid particles of lithium hydride in a vacuum are discussed, and the results obtained are compared with the theoretical models. Experimental measurements of the interaction of these plasmas in mirror and cusp magnetic fields are discussed. The current status of the research program is evaluated and areas for further investigation of these plasmas are outlined. (M.O.W.)

11472 THE MINIMUM SPECIFIC ENERGY AND ELECTRIC FIELD NECESSARY TO SUSTAIN A FLOWING INDUCTION PLASMA. Seemann, G. R.; Penfold, A. S.; Thornton, J. A. (Litton Industries, Beverly Hills, Calif.). J. Appl. Phys., 39: 340-2(Jan. 1968).

The minimum values of specific energy and electric field of induction which will maintain, in a flowing argon plasma, an intense and stable discharge of the electrodeless type, are reported. The measurements offer evidence that the plasma supports a non-Maxwellian distribution of electron energies. (M.H.R.)

11473 VOLTAGE-CURRENT CHARACTERISTICS AND EFFICIENCY OF ELECTRIC ARC HEATER WORKING WITH DIFFERENT GASES. Yurevich, F. B.; Volk-Levanovich, M. V.; Shashkov, A. G. (Inst. of Heat and Mass Transfer, Minsk). Inzh.-Fiz. Zh., 12: 711-17(June 1967). (In Russian).

Static and dynamic voltage–current characteristics of a linear electric arc heater with an arc stabilized by argon, nitrogen, air and oxygen are obtained. The empirical expression for calculating voltage–current characteristics in a dimensionless form in experiments with nitrogen, air and oxygen is proposed. The obtained values of electric and thermal efficiency of a heater investigated with various gases are analyzed. (auth)

11474 SOME RESULTS OF EXPERIMENTAL STUDY OF HEAT TRANSFER IN THE DISCHARGE CHAMBER OF A PLASMA GENERATOR WHEN THE ARC IS INFLUENCED BY THE MAGNETIC FIELD AND EDDY GAS FLOW. Andryushkevich, M. B.; Borovchenko, E. A.; Iskrenkov, A. P.; Toropov, V. V.; Sharakhovskii, L. I. (Inst. of Heat and Mass Transfer, Minsk). Inzh.-Fiz. Zh., 13: 147-53(Aug. 1967). (In Russian).

It is shown that the net convective and radiative heat flow to the electrodes of the coaxial plasma generator may exceed the heat flow from the moving arc spot within the region of arc burning. In this case the net convective and radiative heat flux depends essentially on mutual direction of dynamic and magnetic revolution of the arc. (auth)

11475 POSITIVE ION HEATING OF PLASMAS PRODUCED FROM THE SOLID STATE. Ross, David Paul. Fayetteville, Ark., Univ. of Arkansas, 1967. 193p.

Thesis.

A technique for measuring the positive ion temperatures of plasmas produced in vacua was developed. The technique, which involves the determination of the translational temperature through a velocity analysis of time-of-flight data, was applied to plasmas produced by the explosion of wires. Analyses indicated that the plasmas occasionally developed temperature in excess of 10^6°K. Such high temperatures are neither experimentally expected nor theoretically predicted. Experimental information, additional to the positive ion temperature measurements, are developed to show that under certain circumstances an exploding wire may produce a plasma which is rather than the usually assumed joule heating in a static pinch. The evidence developed, which included current–voltage data, time-resolved total light output, and time-integrated photographs, supports the following behavior: a large current with a critically damped waveform is delivered to the wire which changes phase from solid to liquid to superheated liquid as the current rises to a maximum value (30,000 A). Vapor released by the surface of the superheated liquid breaks down electrically after about 25% of the wire material has been converted to vapor, and the plasma so produced is dynamically pinched to the liquid core. The core first stabilizes the plasma against ejection from the circuit, and then expands to eject the plasma from the discharge region. The wires used in this study have been gold, copper, and aluminum in two diameters, 0.045 and 0.062 cm, and 1-cm long. The electrical circuit used consisted of a 60-μf capacitor in a critically damped circuit capable of delivering approximately 100 J to a wire in about 10 μsec. These parameters differ from those employed by others seeking to produce high temperatures in exploding wires in the following respects: the wires used are shorter and thicker, the energy delivery system is slower and delivers less energy, and the ambient pressure is much lower. It is speculated that because the combination of parameters used leads to formation of a plasma peripheral to a liquid core at current maximum, the high temperatures measured are unique in work of this type. It is also possible that the unique method of ion temperature determination leads to the measurement of temperatures undetectable by more conventional techniques. (Diss. Abstr.)

11476 PLASMA METHOD AND APPARATUS FOR GENERATING ENERGY. Smullin, Louis D. (to LIPHA, Lyonnaise Industrielle Pharmaceutique). U. S. Patent 3,361,634. Nov. 16, 1962.

A method of the character described that comprises generating a gaseous plasma including electrons, magnetically confining the plasma as a floating body within a predetermined spatial region, injecting a dense high-voltage electron beam into the said spatial region and thus into the plasma, adjusting the electron beam voltage to the order of at least hundreds of thousands of volts, adjusting the current density of the electron beam such that the ratio of the number of electrons in the beam to the number of electrons in the plasma is sufficiently large, namely to provide a ratio of electron beam current to the three-halfs power of the electron beam voltage of the order of at least 10^{-4}, to cause an avalanche of sustained oscillations between the plasma and the electrons, with the electron beam collision frequency small compared with the frequency of the said oscillations, and extracting energy of the plasma at a region displaced from the said spatial region. (auth)

Stability of Plasma

11477 (ORNL-TM-2025) STABILITY OF THE GUIDING CENTER PLASMA. Nelson, David B. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 44p. Dep. CFSTI.

Thesis. Submitted to New York Univ., N. Y.

Using a variational principle for the guiding-center plasma, the implications for absolute stability of local stability plus interchange stability are examined. The geometry chosen for this analysis is open-ended, with magnetic lines free to interchange at the ends. The method of analysis uses the fact that any admissible variation away from an equilibrium can be decomposed into an interchange plus a variation which vanishes at one end of the plasma domain. Then the second variation, as a quadratic form, is accordingly separated into three terms which are examined separately. It is found that if the spatial magnetic field and plasma gradients are sufficiently small, then local stability plus

a strong form of interchange stability do suffice for absolute variational stability. This strong form is actually weaker than most of the sufficient conditions for interchange stability which have previously been derived. It is shown that for a plasma which satisfies these criteria stability is independent of the plasma length; i.e., lengthening such a plasma does not destroy its stability. (auth)

11478 CONTRIBUTION TO THE QUASILINEAR THEORY OF INSTABILITY OF A PLASMA WITH AN ANISOTROPIC DISTRIBUTION OF ION VELOCITY. Shapiro, V. D.; Shevchenko, V. I. pp 19-24 of Vysokochastotnye Svoistva Plazmy. Sinel'nikov, K. D. (ed.). Kiev, Naukova Dumka, 1967. (In Russian).

This is a continuation of earlier work (Zh. Eksp. Teoret. Fiz., 45: 1612(1963)) dealing with quasilinear relaxation of a plasma with anisotropic ion velocity distribution in a magnetic field. The present paper solves the differential equation derived in the earlier paper for the variation of the ion distribution function with the magnetic-field energy, using a specific set of initial conditions. The expression for the distribution function is obtained in series form, the asymptotic behavior of which is investigated. Some of the results agree with those of the earlier paper, but have been derived with greater mathematical rigor. The stability of the system is briefly discussed. (ATD)

11479 NONLINEAR INTERACTION OF WAVES IN THE PRESENCE OF BEAM INSTABILITY. Kropotkin, A. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 1765-75(Nov. 1967). (In Russian).

The development of kinetic beam instability in a plasma may be determined not by quasi-linear effects but by nonlinear interaction between the produced Langmuir waves. For this it is sufficient that the waves be confined to a finite volume and their decay and transformation into other modes be weak. A nonlinear equation is found which describes the evolution of the oscillation energy spectrum in this case and an asymptotic (for large times) stationary solution of the equation is found. The solutions describe stationary energy spectra of oscillations which considerably differ from those which the quasi-linear theory yields. (auth)

11480 STABILITY OF A HOMOGENEOUS PLASMA WITH ISOTROPIC DISTRIBUTION FUNCTIONS IN A MAGNETIC FIELD. Korablev, L. V. Zh. Eksp. Teor. Fiz., 53: 1600-9 (Nov. 1967). (In Russian).

It is shown that in a homogeneous plasma with isotropic particle velocity distribution functions located in a stationary magnetic field buildup of potential oscillations may occur providing that besides the main plasma fast ions with $f \sim \delta(\nu - \nu_0)$ are also present. Criteria for development of such a plasma are obtained. The theory is applied to a thermonuclear deutero-tritium plasma in which fast ^4He ions with an isotropic distribution function are produced in the synthesis reaction. If the thermonuclear plasma temperature is T = 35 to 11 keV instability develops on cyclotron ion harmonics with $n \gtrsim 5$ to 6 and $n \gtrsim 7$ to 14. (auth)

11481 INFLUENCE OF HIGH FREQUENCY FIELD UPON PLASMA INSTABILITIES. Ivanov, A. A.; Rudakov, L. I.; Teikhmann, I. Zh. Eksp. Teor. Fiz., 53: 1690-2(Nov. 1967). (In Russian).

Method of plasma stabilization is proposed for a plasma immersed in magnetic field, with magnetic force lines oscillating about the equilibrium state with a small amplitude and frequency higher than increment. (auth)

11482 TRANSVERSE WAVE INSTABILITIES IN A PLASMA WITH AN AXIALLY SYMMETRICAL VELOCITY DISTRIBUTION. Takeo, Akimasa (Tokyo Univ.). J. Phys. Soc. Jap., 23: 1415-20(Dec. 1967).

An instability criterion of a plasma with an axially symmetrical velocity distribution for transverse waves propagating perpendicularly to the axis of symmetry is derived by means of a Nyquist-diagram technique in the absence of an external magnetic field. (M.O.W.)

Thermonuclear Processes

11483 INSTABILITY OF INHOMOGENEOUS PLASMA CAUSED BY THERMONUCLEAR REACTION PRODUCTS. Kolesnichenko, Ya. I.; Oraevskii, V. N. At. Energ. (USSR), 23: 289-91(Oct. 1967). (In Russian).

The stability of inhomogeneous plasmas during the occurrence of thermonuclear reactions in them was investigated. It is shown that, beginning with certain values of the concentration of the products of thermonuclear reactions (charged particles forming as a result of the thermonuclear reaction and remaining in the system) in the thermonuclear plasma, instability develops. The time for the development of the instability is much shorter than the characteristic relaxation time. The instability practically does not affect the diffusion of the reacting ions. For analysis of the stability of systems, functions of the distribution of products of thermonuclear reactions in inhomogeneous plasma were introduced. (tr-auth)

Shielding

11484 (JINR-P4-3614) ZERKAL'NOE OTRAZHENIE NEITRONOV I γ-KVANTOV. (Mirror Reflection of Neutrons and γ-KVANTOV. (Mirror Reflection of Neutrons and γ-Quanta). Baryshevskii, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep.

Attention is paid to the fact that the mirror reflection coefficient of γ quanta (neutrons) is not determined by the index of refraction. The dependence of the reflection coefficient on the angle is closely connected with the angular dependence of the scattering amplitude in a rigidly fixed center and with the transition region existing on the matter boundary. As for γ quanta, this fact, in particular, leads to the observation that the Frenel formulas do not describe their mirror reflection. (auth)

11485 (ORNL-4211) SHIELDING CALCULATIONS FOR A 400-MeV LINEAR ELECTRON ACCELERATOR. Alsmiller, R. G. Jr.; Barish, J.; Boughner, R. T.; Engle, W. W. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 47p. Dep. CFSTI.

Shielding calculations for a linear electron accelerator may conveniently be divided into four parts: the electron–photon cascade, photoneutron production, particle transport through the shield, and the conversion of particle current leaving the shield to dose. Calculations in each of these categories have been carried out to aid in the design of the transverse shield of a 400-MeV linear electron accelerator. In particular, neutron-transport calculations, which are carried out using three approximation methods, the straightahead approximation, the straight-ahead approximation coupled with a low-energy discrete ordinates calculation, and the straightahead approximation coupled with a Monte Carlo calculation, are presented and compared. Shields composed of silicon dioxide and silicon dioxide with 10% water by weight are considered. (auth)

11486 (TRG-Report-1466) ATTOW: A TWO-DIMENSIONAL SHIELDING PROGRAM. Collier, W. D.; Curtis, G. C. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Sept. 20, 1967. 57p. (JNPC-SWP/P-127). Dep. CFSTI. UK 8s. 0d.

ATTOW is a shielding code programmed in FORTRAN IV for the IBM 7090 computer. It solves the multigroup diffusion equations in two dimensions for nonmultiplying media. Any number of groups is allowed but neutron transfer is only allowed from higher groups to lower. There may be up to 100×100 mesh points over a rectangle within which materials may be mapped out as required. Any distribution of neutron sources can be specified, derived if desired from the built-in removal program. Output includes flux prints, neutron currents and detector activations. The data requirements are given in detail, and the use of the program is illustrated. The method of solution of the equations is also described. (auth) (UK)

11487 (ORNL-tr-1884) CALCULATION OF DOSE DERIVATIVES BY MONTE CARLO FOR OPTIMIZATION OF SHAPE AND COMPOSITION OF SHIELDS. Brainina, M. Z.; Generozov, V. L.; Kuznetsov, V. G.; Sakovich, V. A. Translated for Oak Ridge National Lab., Tenn., from Zh. Vychisl. Mat. i Mat. Fiz., 7: 953-7(1967). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Optimum shape and composition for a minimum weight shield may be determined using gradient programming; at each step of the iteration process, it is necessary to know only the first derivatives of dose beyond the shield. The derivatives may be calculated simultaneously with the dose calculations by the Monte Carlo method. Two cases of shield optimization are considered, with examples: optimum volume densities for given shield shape, and optimum shield shape for uniform composition. (D.L.C.)

11488 ANALYTIC TREATMENT OF ARBITRARY ANISOTROPIC SCATTERING IN THE ENERGY DEPENDENT TRANSPORT THEORY. Gerstl, S. A. W. (Univ. Fridericiana, Karlsruhe, Ger.). Nukleonik, 10: 227-36(Nov. 1967).

A generalized spherical harmonics method is outlined to solve the one-dimensional energy and angular dependent transport equation in slab geometry, whereby any anisotropy of the scattering cross section can be treated analytically exact. The angular dependency of the scattering cross section is described in a very

general form by means of so-called "Anisotropy Functions" for which analytic expressions and recurrence formulas are stated. The applicability of this method is demonstrated by shielding calculations for gamma rays. Here, the spectra of the transmitted and reflected energy flux show new discontinuities which represent a typical boundary effect but were not observed before. (auth)

11489 BACKSCATTER OF NORMALLY INCIDENT GAMMA PHOTONS FROM SEMI-INFINITE MEDIA OF VARYING ATOMIC NUMBER. Steyn, Julian Jack. Toronto, Univ. of Toronto, 1966.

Thesis.

Normally incident gamma photon backscattering from assumed semi-infinite media was experimentally measured and analyzed as a function of the atomic number of the media, angles of scatter and incident primary photon energies. The sources of primary photons were assumed point sources of ^{198}Au, ^{137}Cs and ^{60}Co located at one meter distance from the scattering medium. The photon energies of the sources were taken as 0.412, 0.662 and 1.25 (mean) MeV. The materials of the scattering media were graphite, aluminum, Ilmenite shielding concrete, iron, nickel, tin, lead, and uranium. Six backscattering angles were studied, ranging from 100° to 148°. The scattered photons were detected by means of a highly collimated NaI(Tl) shielded scintillation-crystal angular spectrometer whose output was fed to a multichannel pulse-height analyzer. The measured spectra were analyzed on IBM-7094 and IBM-1620 digital computers. The methods of analysis employed an iterative matrix inversion procedure. A derivation for the accurate determination of the detector collimator geometrical aperture is given. An efficient spectral gain-changing program was developed as an aid in analysis. The results are presented both graphically and in table form. They consist of pulse-height analyzer spectra; angular–energy differential photon number, energy and dose spectra; angular differential number, energy and dose current albedos; angular differential dose flux ratios; angular differential number, energy and dose x-ray albedos, or reflection coefficients; total number, energy and dose albedos. An empirical relationship is presented to describe the differential dose current albedos and total albedos as a function of scattering angle, incident photon energy and scattering medium atomic number. The results where possible are compared to the relatively few published Monte Carlo and existing experimental data. The present study results generally exceed those previously published by 20%. The results of the present research, however, are substantiated by a high degree of self-coherence. (Disser. Abstr.)

Solid-State Physics

Refer also to abstracts 10263, 10610, 10650, 11003, 11019, 11197, 11204, 11207, 11343, 11944, and 11945.

11490 (CONF-661216-4) DIFFRACTION DES NEUTRONS AVEC DES SOURCES CONTINUES ET DES SOURCES PULSEES DE NEUTRONS. COMPARAISON DES DIAGRAMMES DE $FeBiO_3$. (Neutron Diffraction with Continuous and Pulsed Neutron Sources. Comparison of Diagrams of $FeBiO_3$). Roult, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1966]. 15p. (In French). (N.I.-66/7). Dep. CFSTI.

From Conference on the Study of Structures by the Use of Neutrons, Moscow, USSR.

The traditional and time-of-flight methods of neutron diffraction with continuous and pulsed neutron sources are compared with respect to intensity and resolution. Diffraction diagrams of $FeBiO_3$ obtained with the Siloe Reactor at Grenoble, at Petten, and at Dubna are given and compared. The results show that the two methods should be considered as complementary. The time-of-flight method, particularly with pulsed neutrons, is more advantageous with respect to intensity. The traditional method offers advantages with respect to the peak/background ratio. (J.S.R.)

11491 (IN-1148) ADJUSTER: A FORCE CONSTANT ADJUSTER PROGRAM TO OBTAIN LEAST SQUARES FIT TO OBSERVED FREQUENCIES OF MOLECULES AND CRYSTALS. Boyter, J. K.; McMurry, H. L. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 6p. Dep. CFSTI.

A FORTRAN program for the IBM 7040 is described which is a force-constant adjuster to obtain a least squares fit to observed frequencies of molecules and crystals. The J input cards may be punched by the program MACS J(PPCo 40*0929), described in IN-1147. (auth)

11492 (NP-17210) THEORY OF ELECTRON TRANSPORT PROCESSES IN TUNNEL DIODES. Report No. 214. Faiman, Michael (Illinois Univ., Urbana. Dept. of Computer Science). Sept. 19, 1966. 60p.

Thesis.

A unified theory of conduction processes in tunnel diodes is presented. The use of Fermi–Dirac distributions in nonequilibrium tunneling integrals is justified. The direct tunneling mechanism is examined from two points of view and is shown to be described about equally well by both. In subsequent sections, indirect tunneling and the phenomena of excess and thermal currents are treated. (auth)

11493 (JPRS-42628, pp 30-42) CHANGES IN THE MECHANICAL CHARACTERISTICS OF SOME SOLIDS FROM THE ACTION OF GAMMA-RAYS. Starodubtsev, S. V.; Azizov, S. A.; Domoryad, I. A.; Peshikov, E. V.; Khiznichenko, L. P. Translation of pp 347-54 of Deystviye Yadernogo Izlucheniye na Materialy, Academy of Sciences, USSR, 1962.

The effect of γ radiation on some mechanical and dielectric properties of solids is investigated. The studies were conducted on samples of fused quartz in the form of fibers, crystals of Seignette salt of various sections, and on samples of ceramic barium titanate. The high demands for sensitivity and accuracy in the methods of recording the radiation changes are given special attention in this work. The irradiation was carried out in a ^{60}Co γ apparatus with an energy of 1.25 MeV and a dose rate of 10^6 roentgens/hour. (M.H.R.)

11494 (UCRL-Trans-10165) OPTICAL PROPERTIES OF THE SOLID SOLUTIONS IN ZINC AND IRON ORTHOSILICATE. Dobrotsvetov, B. L. Translated by A. M. A. Mincer for Univ. of California, Lawrence Radiation Lab., Livermore, from Vestn. Mosk. Univ., Ser. IV, Geol., 20: 37-45(1965). 21p. Dep. CFSTI. JCL $2.60 fs, $0.83 mf.

Optical-refraction and x-ray-diffraction studies were used to investigate mutual solubilities in the Zn_2SiO_4–Fe_2SiO_4 system and the relationship between optical properties and composition. It was found that at high temperatures Fe and Zn orthosilicates can mix in any proportion. On cooling the continuous series of solid solutions decomposes with preservation of two series near the compositions of the starting compounds. The mutual solubility limits were found to be 25% of Zn_2SiO_4 in Fe_2SiO_4 and 27% of Fe_2SiO_4 in Zn_2SiO_4. It was also concluded that experimental composition–optical property diagrams can be used to determine the Zn content in Fe_2SiO_4 or Fe in Zn_2SiO_4. (A.G.W.)

11495 (UCRL-Trans-10166) KINETIC STUDY OF SCINTILLATION IN PURE ORGANIC CRYSTALS. Blanc, D.; Cambou, F.; Gervais de Lafond, Y. Translated by F. D. Jones for Univ. of California Lawrence Radiation Lab., Livermore, from J. Phys. (Paris), 25: 319-25(1964). 25p. Dep. CFSTI. JCL $2.60 fs, $0.98 mf.

Previous theories of the fast component of scintillation in organic crystals are perfected and generalized by setting up an equation giving the general law of variation of density of the fast-generated singlet quanta of excitation. This equation is applied to a particular case less restrictive than those of the previous theories. The hypothesis of a bimolecular activation from the lowest triplet state to the first excited singlet state is then used as a basis for a kinetic study of the slow component, from which the relative amount of this component is determined for the two cases of particle and photon excitation. (auth)

11496 IMPROVED DEMAGNETIZATION CRYOSTAT FOR MOESSBAUER EFFECT EXPERIMENTS. Shinohara, Motoo; Ishigaki, Atsushi; Ono, Kazuo (Tokyo Univ.). Jap. J. Appl. Phys., 7: 170-3(Feb. 1968).

Some improvements in a previously constructed demagnetization cryostat for use in Mössbauer effect experiments have been made. In the new design, a mechanical heat switch previously used for establishing thermal contact between the paramagnetic salt and the liquid helium bath was replaced with helium exchange gas: the use of vacuum-tight beryllium windows made this possible. CrK alum or $MnNH_4$ Tutton salt weighing 60 g was used as a cooling salt. The lowest temperature reached by using CrK alum was 0.025°K and the temperature of the alum arrived at 0.05°K in 6.5 hr. The lowest temperature reached by using $MnNH_4$ Tutton salt was 0.15°K and the temperature was practically constant as long as liquid helium stayed in the bath. The magnetic hyperfine structure of $K_3Fe(CN)_6$ (T_N = 0.13°K) has been observed by employing this cryostat, and the internal magnetic field at the position of an iron nucleus in $K_3Fe(CN)_6$ was found to be 193 kOe. (auth)

11497 NUMERICAL ESTIMATION OF MOESSBAUER SPECTRA PARAMETERS. Duke, B. J. (Univ. of Lancaster, Eng.); Gibb, T. C. J. Chem. Soc., A, No. 9, 1478-83(1967).

The general problem of estimating parameters which occur non-linearly in a model representing experimental data arises in a variety of chemical problems and is discussed in relation to Mössbauer spectra. Various numerical methods, currently available,

are discussed and compared. An overall strategy is outlined and the accuracy of the estimated parameters is considered. (auth) (UK)

11498 MOESSBAUER SPECTROSCOPY WITH POLARIZED MONOCHROMATIC RADIATION. Shtrikman, S. (Weizmann Inst. of Science, Rehovoth, Israel). Solid State Commun., 5: 701-3(Sept. 1967).

The possibility of carrying out Mössbauer experiments with monochromatic linearly polarized radiation is demonstrated. Mössbauer spectra of a transversely magnetized iron foil for radiation polarized parallel and perpendicular to the magnetization are given. (auth) (UK)

11499 METHOD OF STUDYING THE DYNAMICS OF RADIATION DEFECTS IN CRYSTALS BY MEANS OF A COMPUTER. Klimenkov, V. I.; Kirsanov, V. V.; Osipova, Z. Ya. At. Energ. (USSR), 23: 356-8(Oct. 1967). (In Russian).

A small region of crystal around the initial position of a primary displaced atom is considered on replacing the remainder of the crystal by an elastic continuum. The motion of atoms in this microcrystal is described by classic equations The microcrystal size and its form are determined by the energy of the displaced atom, by the size of the computer memory, and by the extent of the problem to be solved. For example, microcrystals of copper consisting of 446 or 998 atoms have been considered qualitatively at imparted energies of 30 to 400 eV. A flow diagram of a computer program for 172 atoms is presented. The results of the calculations were in agreement with theory, and thus confirmed the program. In addition, a microcrystal of α-iron containing 246 atoms was modeled. A number of problems on the dynamics of radiation defects can be solved by this method. (TTT)

11500 DENSITY CHANGES IN ATOMIC-PILE-IRRADIATED POLYACRYLONITRILE. Beevers, R. B. (Univ. of Bradford, Eng.). J. Appl. Phys., 39: 335-7(Jan. 1968).

X-ray measurements on polyacrylonitrile which has been irradiated in an atomic pile at dosages up to 3×10^8 rad show a relatively small amount of change in the scattering diagrams. Samples were examined in the form of compressed disks and dosages calculated from viscosity measurements on Perspex solutions in chloroform. Density measurements showed a linear relation with dosage and provide a relatively simple and sensitive new dosimetry system. (auth)

11501 THE SAHA–LANGMUIR EQUATION AND ITS APPLICATION. Dresser, M. J. (Washington State Univ., Pullman). J. Appl. Phys., 39: 338-9(Jan. 1968).

A previous paper discusses the use of the Saha–Langmuir equation and suggests some modifications of its form. It is the contention here that some of these suggestions may be misleading. (M.H.R.)

11502 EFFECTS OF THERMAL NEUTRON IRRADIATION IN p-TYPE SILICON. Bunting, B. A.; Verghese, K.; Saxe, R. F. (North Carolina State Univ., Raleigh). J. Appl. Phys., 39: 342-3 (Jan. 1968).

Float-zone refined silicon single-crystal samples with an initial boron concentration in the vicinity of 10^{12} atoms/cm^3 were irradiated to an integrated thermal neutron flux of 3.4×10^{16} neutrons/cm^2, at a cadmium ratio of 1100, corresponding to the creation of 6.0×10^{12} phosphorus atoms/cm^3. Using electroless nickel-plated contacts, resistivity measurements were made by the two-point probe method at room temperature, and also the minority carrier lifetime was measured as a function temperature in the range from 160 to 300°K, using the photoconductive decay method. (M.H.R.)

11503 EFFECT OF NEUTRON IRRADIATION AT 4.5°K ON GUINIER–PRESTON ZONE FORMATION IN ALUMINUM–ZINC ALLOYS. Horak, J. A. (Argonne National Lab., Ill.); Blewitt, T. H.; Fine, M. E. J. Appl. Phys., 39: 326-35(Jan. 1968).

The effect of fast neutron irradiation at 4.5°K on Guinier–Preston zone formation in the reverted as well as quenched alloys of Al–1.70 to 5.27 at. % Zn has been studied by means of electrical resistivity measurements. There is no indication of zone formation during irradiation nor during stage I and stage II of the isochronal annealing, but there is a large enhancement in the kinetics of zone formation during stage-III annealing. The large increase in resistivity associated with zone formation begins at about 150° with the resistivity maximum occurring at about 260°K. Comparison with stage-III recovery in pure aluminum suggests that vacancy migration, which controls Guinier–Preston zone formation in these alloys, results in stage-III recovery in pure aluminum. In addition, there is an indication of solute-atom–vacancy binding and/or vacancy trapping by the zones since stage III extends to higher temperatures in the alloys than in pure aluminum. (auth)

11504 COMPRESSIONS OF ISOTOPIC LITHIUM HYDRIDES. Stephens, D. R.; Lilley, E. M. (Univ. of California, Livermore). J. Appl. Phys., 39: 177-80(Jan. 1968). (UCRL-12386(Rev.1)).

The compressions of ^{7}LiH, ^{7}LiD, ^{6}LiH, and ^{6}LiD were measured to 40 kbar at 23°C. The data fit well to both the simple Born–Mayer model and the Murnaghan equation. The 1-atm compressibilities varied from 2.8 to 2.9 mbar^{-1}. The data do not agree well with other reported results. (auth)

11505 INVESTIGATION OF NEUTRON-IRRADIATION DAMAGE IN SILICON BY TRANSMISSION ELECTRON MICROSCOPY. Pankratz, J. M.; Sprague, J. A.; Rudee, M. L. (Rice Univ., Houston, Tex.). J. Appl. Phys., 39: 101-6(Jan. 1968).

Dislocation-free single crystals of three types of silicon have been irradiated by 6×10^{17} and 5×10^{19} nvt of fast neutrons and studied by bright- and dark-field transmission electron microscopy. Mean defect image size has been found to depend on the impurity content of the silicon and annealing treatment, ranging from 22 Å in the most nearly pure silicon in the as-irradiated state to a maximum of 40 Å in the n-type silicon after a 30-min anneal at 700°C. Defect density ranges from 10^{17} images/cm^3 in the as-irradiated state to less than 10^{15} after a 1000°C anneal for 30 min. The density is not noticeably affected by the type of impurity, but is approximately proportional to neutron dosage. The properties of the images formed by diffraction contrast in thin silicon foils have been studied by extending the solutions of the basic equations of the dynamical theory of diffraction contrast with anomalous absorption to defects of the small size encountered in the research. An anomalously wide black–white image is predicted in dark field from which it is possible to determine whether a defect has interstitial or vacancy character. A ratio in the order of 2 to 1 interstitial type to vacancy type was found in the n-type silicon; the ratio in the other two types of silicon appeared to be more nearly unity. (auth)

11506 LENGTH CHANGE OF COPPER AFTER ELECTRON IRRADIATION. Hanada, R.; Kauffman, J. W. (Northwestern Univ., Evanston, Ill.). Appl. Phys. Lett., 12: 42-4(Jan. 15, 1968).

The length change of pure copper after 2.2-MeV electron irradiation was measured with a sensitivity of 3×10^{-8} at liquid-helium temperature. Subsequent isochronal annealing showed the existence of substructures in stage 1. These substructures in length change are found to be similar to resistivity recovery results. (auth)

11507 X-RAY-LUMINESCENCE OF RUBY MONOCRYSTALS. Sujak, B. (Wroclaw Univ.); Niklas, A. Acta Phys. Pol., 32: 711-18(Nov. 1967).

The thermoluminescence of $Al_2O_3 + Cr^{3+}$ (0.08% and 0.1% of Cr_2O_3) irradiated by x rays (Cu, 50 kV, 8 mA) was investigated. It was found that the curves of integral x-ray-luminescence and thermoluminescence are identical for linear temperature increase. For x-ray-luminescence glow in the investigated range of spectrum two wavelengths are emitted: 697 nm and 670 nm at the temperature of 300°K and 702 nm and 674 nm at 615°K. Investigation of thermoluminescence for the wavelength of 697 nm showed that the shape of the glow curve for light from the region of the R line is more similar to the curve of thermostimulated (exo)emission of electrons than for the wavelength of 670 nm. (auth)

11508 ANGULAR DISTRIBUTIONS OF PHOTONS FROM TWO-QUANTUM ANNIHILATION OF POSITRONS IN SELENIUM, TELLURIUM, AND THEIR ALLOYS. Cangas, A.; Jelenska-Pienkowska, H.; Swiatkowski, W.; Wesolowski, J. (Wroclaw Univ.). Acta Phys. Pol., 32: 719-23(Nov. 1967).

Angular distributions of photons from two-quantum annihilation of positrons in crystalline selenium, tellurium, and their alloys were measured. The number of electrons in the valence band per one atom was estimated for these substances on the basis of these distributions using the band model of a solid. The results are in agreement with the number of electrons in outer shells of the Se and Te atoms. (auth)

11509 MOTION OF ENERGETIC PARTICLES IN CRYSTALS. Datz, Sheldon (Oak Ridge National Lab., Tenn.); Erginsoy, Cavid; Leibfried, Guenther; Lutz, Hans O. Contract W-7405-eng-26. Annu. Rev. Nucl. Sci., 17: 129-88(1967). (ORNL-P-2994).

The first part of this review of the effects of crystalline structure on particle trajectories close to the symmetry directions of the crystal is concerned with the theory of particle motion in crystals. Measurements of ranges of heavy ions in crystals and transmission through thin crystals are then summarized and available data are tabulated. Investigations of nuclear reactions, x-ray yields, radiation damage, Rutherford scattering, and emission from lattice sites are reviewed. Meth-

ods for studying spatial distributions of ions emerging from single-crystal targets are described. (139 references) (A.G.W.)

11510 ISOMER CHEMICAL SHIFTS OF THE MOESSBAUER γ LINE IN ISOELECTRONIC ANTIMONY COMPOUNDS. Bryukhanov, V. A.; Iofa, B. Z.; Kotkhekar, V.; Semenov, S. I.; Shpinel, V. S. (Inst. of Nuclear Physics, Moscow. Moscow State Univ.). Zh. Eksp. Teor. Fiz., 53: 1582-8(Nov. 1967). (In Russian).

The isomer chemical shifts (ICS) of the 37.2-keV γ line of ^{121}Sb in isoelectronic complex antimony salts $NaSbF_6$, $NaSb(OH)_6$, $HSbCl_6 \cdot xH_2O$ and also in the compounds Sb_2O_3, Sb_2O_5, $SbCl_5$, InSb, and Sb are measured. The ^{121m}Sn isotope in the $\beta-Sn$ and SnO_2 lattices is employed as the resonance γ source. For SnO_2 the emission line of 37.2-keV resonance γ quanta is singlet and practically unbroadened whereas the Mössbauer effect (fraction of nonrecoil quanta f) at T = 78°K exceeds f for the $\beta-Sn$ source and is $f_{78}(SnO_2) = 0.32^{+0.04}_{-0.02}$. The dependence of the ICS on the electronegativity of the antimony ligand for six-coordination antimony compounds is found to be linear just as in the case of six-coordination tin compounds of the $SnHal_6^{-2}$ type. By comparing these dependences the relation has been obtained between the relative variations of the mean square charge radii for two Mössbauer γ transitions, e.g., for the 37.2-keV transition in ^{121}Sb and the 23.8-keV transition in ^{119}Sn: $(\delta R/R)_{Sb}/(\delta R/R)_{Sn} = -(5.5 \pm 0.3)$. Calibration of the magnitude of the ICS corresponding to detachment of a 5s electron in the Sb atom is performed by extrapolating the dependence of the ICS dependence to a completely covalent bond. The value thus found is 29×10^{-7} eV (23 mm/sec). Measurements of the magnitude of the resonance effect as a function of thickness of the Sb_2O_3 absorbers yield a value ~10 for the total resonance internal conversion coefficient. (auth)

11511 MAGNETIC RESONANCE ON ^{141}Pr NUCLEI IN A $Pr_2(SO_4)_3.8H_2O$ SINGLE CRYSTAL. Teplov, M. A. (Kazan State Univ.). Zh. Eksp. Teor. Fiz., 53: 1510-15(Nov. 1967). (In Russian).

Nuclear magnetic resonance of ^{141}Pr in a $Pr_2(SO_4)_3 \cdot 8H_2O$ single crystal is studied experimentally. It is shown that the NMR spectra can be described by the nuclear spin hamiltonian (1) with the values of coefficients from (4). The quadrupole interaction parameters are determined (5). The experimental method is described and the results are discussed. (auth)

11512 ECONOMIC METHOD OF MAGNET CONSTRUCTION GIVING A LARGE VOLUME OF HIGH-HOMOGENEITY FIELD. Richmond, I. J.; Parker, D. W. (Newport Instruments Ltd., Newport Pagnell, Eng.). pp 129-34 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

For moderate homogeneity at low field values the Watson magnet offers considerable advantages over more conventional methods of magnet construction as regards size, weight, and cost. The volume of homogeneous field is roughly the same as can be obtained in a conventional magnet having an equal gap volume. It makes possible the production of a portable NMR quantity analyser for sample volumes up to about 100 ml. This technique of magnet construction is capable of being scaled up to provide larger volumes of homogeneous field, permitting the use of larger samples and making possible the use of NMR techniques for on-line process control on an industrial scale. At the other extreme, it can provide simple and cheap magnets for low-resolution resonance studies and for teaching purposes. (auth) (UK)

11513 MEASUREMENTS ON MAGNETIC SMALL-ANGLE SCATTERING OF THERMAL NEUTRONS IN UNMAGNETIZED IRON. Mathur, J. N. (Univ., Kiel). Atomkernenergie, 13: 50-6(1968). (In German).

When a well-collimated beam of thermal neutrons is passed through samples of unmagnetized iron, the beam is found to diverge in very small angles of the order of minutes. But as soon as the samples were slightly magnetized the broadening of the beam disappeared. The purpose of this work was to find out the cause of this broadening of the beam. The experimental results were compared with the two contradictory theories (refraction or diffraction) and it was found that for the domain size and the neutron wavelength under consideration, the cause of the small-angle scattering was refraction of neutrons at domain boundaries. (auth)

11514 MOESSBAUER EFFECT OF ^{57}Fe IN $Fe(OH)_2$. Miyamoto, Hiroki; Shinjo, Teruya; Bando, Yoshichika; Takada, Toshio (Kyoto Univ.). J. Phys. Soc. Jap., 23: 1421(Dec. 1967).

Moessbauer spectra were measured at 90 and 4.2°K. Energy levels of ^{57}Fe excited and ground state and transitions between them for $\lambda = -0.75$ and $\theta = 90°$ are shown. (M.O.W.)

11515 OPTICAL ABSORPTION OF NEUTRON-IRRADIATED GRAPHITE. Iwata, Tadao; Sato, Yoshiki (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Jap., 23: 1425(Dec. 1967).

Pyrolytic and natural graphite were used. The neutron irradiations were performed at about 80°C to the fast-neutron flux of about 2.8×10^{17} and 7.9×10^{17} nvt. Optical absorption spectra are given. (M.O.W.)

11516 COLOR CENTER STUDIES IN ALKALI METAL HALIDES BY PULSED ELECTRON BEAM IRRADIATION. Ueta, Masayasu (Argonne National Lab., Ill.). J. Phys. Soc. Jap., 23: 1265-79(Dec. 1967).

The formation and decay of color centers in alkali halides have been studied using a pulsed electron beam. The F- and V-type bands reach maximum heights in optical density at the end of the radiation pulse. V_k and V_1 bands in KBr appear to show the first-order decay kinetics; their room-temperature lifetimes are 1.3 and 3.8 μsec, respectively. A fraction of F and F' bands bleach by the annihilation with migrating V_k centers. The activation energies for the disappearance of H, V_1, and V_k centers in KBr are found to be 0.09, 0.25, and 0.39 + 0.02 eV, respectively. A fraction of H centers in KCl decays with a temperature-independent time constant (~0.13 μsec) which is due to the tunneling with nearby F centers. In crystals containing U centers (H^- ions) the F band continues to grow for several microseconds after the pulse. Absorption bands which decay with the same time constant as the F-band growth have been found at 775 mμ (KBr) and 725 mμ (KCl). (auth)

11517 SOLID-STATE PHYSICS LABORATORIES IN THE USSR. Com. Naz. Energ. Nucl., Notiz., 13: 62-5(Oct. 1967). (In Italian).

The solid state laboratories visited by an Italian delegation to the USSR are briefly described, and the principal research projects of each are outlined. The laboratories visited were the International Institute for Nuclear Research at Dubna, the Leningrad A.F. Ioffe Institute, the Central Scientific Institute for the Problems of Ferrous Metallurgy at Moscow, the Institute of Physics of the Academy of Science of the Ukraine at Kiev, the Technical Physics Institute of the Academy of Science of the Ukraine at Kharkov, and the Kurchatov Institute of the Goskomitet at Moscow. At Dubna the principal research is devoted to high-energy physics, physics of nuclei and nuclear reactions, physics and spectrometry of neutrons, theoretical physics, and calculation and automation. In Leningrad, the Ioffe Institute is divided into three sections: Physics-Engineering Section, Ferrite and Ferroelectric Section, and Semiconductor Section. At the Central Scientific Institute the emphasis is on the application of radioisotope techniques to metallurgy. At Kiev, studies are being made on irradiated materials, reactors, and spectroscopy. The Kharkov Institute has research programs on nuclear physics and plasma physics in addition to programs on solid-state physics. The Kurchatov Institute is undertaking research on cryogenics, internal magnetic fields, specific heats and thermal conductivity of alloys and isotopic mixtures, superconductivity, antiferromagnetic resonance, properties of gases and metallic vapors, photomagnetic and piezophotoelectric phenomena, and neutron spectrometry. (J.S.R.)

11518 OPTICAL PROPERTIES OF THE METAL ReO_3 FROM 0.1 TO 22 eV. Feinleib, J.; Scouler, W. J.; Ferretti, A. (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 165: 765-74 (Jan. 15, 1968).

Absolute-reflectance measurements of single-crystal ReO_3 in the spectral range 0.2 to 22 eV are analyzed by Kramers–Kronig relations to give the real and imaginary parts of the dielectric constants. The dielectric constant is characteristic of free-electron behavior below the sharp plasma edge at 2.1 eV, and confirms the metallic nature of the lustrous red oxide. Interband transitions dominate the optical spectrum above the plasma edge. From this analysis an optical effective mass of $0.86m_0$ is derived. The metallic properties and interband transitions are discussed in terms of proposed band models. (auth)

11519 STAGE-III ANNEALING STUDY OF ELECTRON-IRRADIATED PURE ALUMINUM. Lwin, Y. N. (Argonne National Lab., Ill.); Doyama, M.; Koehler, J. S. Contract AT(11-1)-1198. Phys. Rev., 165: 787-99(Jan. 15, 1968). (COO-1198-499).

Pure aluminum was irradiated at about 90°K using 2-MeV electrons. Isochronal and isothermal annealing studies were carried out. The isochronal anneals were for 10 and 30 min at temperatures 10°C apart. The isothermals were for 64 min at temperatures 20°C apart. The major results were: Stage III occurs by a second-order process with activation energy $E_{III} = 0.62 \pm 0.04$ eV. From the fact that this activation energy agrees well with that

observed after quenching, it is concluded that stage III in aluminum occurs by vacancy migration. (auth)

11520 LINEAR MAGNETORESISTANCE IN THE QUANTUM LIMIT IN GRAPHITE. McClure, J. W.; Spry, W. J. (Union Carbide Corp., Cleveland). Phys. Rev., 165: 809-15(Jan. 15, 1968).

Measurements of the galvanomagnetic properties of single-crystal graphite were made at 4.2°K in pulsed magnetic fields up to 160 kG. With the magnetic field parallel to the c axis, the transverse magnetoresistance is approximately proportional to the magnetic field strength, and the Hall coefficient is constant above about 80 kG. The results imply that both the diagonal and off-diagonal elements of the magnetoconductivity tensors are inversely proportional to the magnetic field strength. The results are explained theoretically using the following facts: (1) both electrons and holes occupy their lowest Landau levels for fields stronger than about 60 kG, (2) degenerate statistics apply throughout the field range, and (3) the scattering is by ionized impurities whose range depends upon the magnetic field strength. The effect provides a simple way to determine the concentration of scattering centers in graphite. It is also definitely established that the concentration of excess carriers must be determined from the off-diagonal magnetoconductivity; use of the high-field Hall coefficient alone leads to large errors. (auth)

11521 INFLUENCE OF FORCE-CONSTANT CHANGES AND LOCALIZED MODES ON THE V:^{57}Fe MOESSBAUER SYSTEM. Mannheim, Philip D. (Weizmann Inst. of Science, Rehovoth, Israel); Simopoulos, A. Contract AF 61(052)-838. Phys. Rev., 165: 845-9(Jan. 15, 1968).

An experimental and theoretical study is made of the Mössbauer effect of ^{57}Fe in a vanadium matrix. The recoil-free fraction and second-order Doppler shift are measured over the temperature range 100 to 700°K. The experimental results are interpreted using recently derived expressions for the mean-square velocity and displacement of the defect, which allow for changes in the force constants as well as the mass at the impurity site. A good fit to the data is obtained for an increase in force constant of approximately 2.5. The data are also analyzed in the high-temperature limit to confirm this increase. Evidence for the presence of localized modes is found from the velocity shift, and the positions of the modes are determined. (auth)

11522 CRYSTAL-STRUCTURE CHANGES IN HYDROGEN AND DEUTERIUM. Schuch, A. F.; Mills, R. L.; Depatie, D. A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev., 165: 1032-40(Jan. 15, 1968). (LA-DC-8153).

The hexagonal-to-cubic-to-hexagonal structure changes in hydrogen and deuterium were studied by x-ray diffraction over many cycles of the transitions for ortho-hydrogen and para-deuterium concentrations up to 95%. Results of the x-ray study can be closely correlated with those of infrared, neutron-diffraction, heat-capacity, nuclear-magnetic-resonance, and volume-change measurements. The structure changes take place by a shifting of the hexagonal nets, which appears to be incomplete after the first transition and may cause intermediate close-packed structures to form. Repeated cycling through the transition stabilizes the cubic structure, possibly because orientation of the J = 0 molecules takes place. (auth)

11523 MOLECULAR FIELD EQUATIONS FOR THE MAGNETIC RESONANCE OF TWO COUPLED SPIN SYSTEMS. Giovannini, B. (Univ., Geneva). Phys. Lett., 26A: 80-1 (Dec. 18, 1967).

New relaxation terms which satisfy the requirement that the energy absorption is always positive are introduced for the description of the magnetic resonance of two coupled spin systems. It is shown that this requirement is equivalent to the detailed balance condition. (auth)

11524 FURTHER EVIDENCE OF THE LOW TEMPERATURE PHASE TRANSFORMATION IN Nb_3Sn AND V_3Si. King, H. W. (Univ. of California, Berkeley); Cocks, F. H.; Pollock, J. T. A. Phys. Lett., 26A: 77-8(Dec. 18, 1967). (UCRL-17944).

Low-temperature x-ray diffraction studies show that the cubic → tetragonal martensitic transformation in Nb_3Sn and V_3Si is accompanied by a change in volume and is therefore a first-order thermodynamic phase change. The axial ratio of the Nb_3Sn martensite is confirmed to be less than unity. (auth)

11525 A NON-LOCAL PSEUDOPOTENTIAL MODEL FOR THE FERMI SURFACE OF BERYLLIUM. Tripp, J. H. (Case Western Reserve Univ., Cleveland); Gordon, W. L.; Everett, P. M.; Stark, R. W. Phys. Lett., 26A: 98-9(Dec. 18, 1967).

Recent de Haas–van Alphen data for the Fermi surface of beryllium have been fitted to within 1% using a nonlocal pseudopotential model. (auth)

11526 ANISOTROPY OF THE NUCLEAR MAGNETIC RESONANCE IN THALLIUM METAL. Schratter, J. J.; Williams, D. L. (Univ. of British Columbia, Vancouver). Phys. Lett., 26A: 79-80(Dec. 18, 1967).

Single crystal studies of the Knight shift parameters in thallium differ significantly from previously reported powder data. (auth)

11527 HYPERFINE MAGNETIC FIELD OF ^{124}Sb IMPLANTED IN IRON. Andrews, H. R. (Harvard Univ., Cambridge, Mass.); Knott, T. F.; Pipkin, F. M.; Santry, D. Phys. Lett., 26A: 58-9 (Dec. 18, 1967).

Nuclear orientation measurements of the hyperfine magnetic field of ^{124}Sb in iron show that essentially the same field is observed whether the source is prepared by diffusion, ion implantation, or implantation followed by high-temperature annealing. (auth)

11528 INTERNAL MAGNETIC FIELD AT AN ANTIMONY IMPURITY IN IRON OR NICKEL. Ruby, S. L. (Argonne National Lab., Ill.); Johnson, C. E. Phys. Lett., 26A: 60-1 (Dec. 18, 1967).

Utilizing the Mössbauer technique, the nuclear magnetic field induced in diamagnetic Sb as an impurity in Fe and Ni has been found to be 245 and 75 kOe, respectively. (auth)

11529 NUCLEAR QUADRUPOLE RESONANCE INVESTIGATION OF $NdBr_3$ AND UI_3. Parks, S. I.; Moulton, W. G. (Florida State Univ., Tallahassee). Phys. Lett., 26A: 63-4(Dec. 18, 1967).

The ^{79}Br and ^{81}Br quadrupole spectra in a single crystal of $NdBr_3$ in the paramagnetic state and the ^{127}I quadrupole spectrum in polycrystalline UI_3 in both the paramagnetic and antiferromagnetic states have been studied. (auth)

11530 NUCLEAR ACOUSTIC QUADRUPOLE RESONANCE IN CsI AND RbI. Tzalmona, A. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 26A: 65-6(Dec. 18, 1967).

The antishielding factors of Cs and Rb ions are measured by nuclear acoustic quadrupole resonance. The nuclear hexadecapole electric moment of ^{133}Cs is estimated to be less than 10^{-46} cm^4. (auth)

11531 CALORIMETRIC INVESTIGATION OF HYPERFINE INTERACTIONS IN RARE-EARTH METALS. Anderson, A. C.; Holmstrom, B.; Krusius, M. (Technical Univ. of Helsinki). Phys. Rev. Lett., 20: 154-7(Jan. 22, 1968).

Results of heat-capacity measurements on Tm and Tb between 0.02 and 0.4°K are shown. Reasons for poor agreement between the data and the theoretical curves are considered. The possibility of a cooperative interaction between nuclei is suggested. (A.G.W.)

11532 QUANTITATIVE TEST OF THE VIBRATIONAL ANISOTROPY ORIGIN OF THE ASYMMETRY OF QUADRUPOLE MOESSBAUER DOUBLETS. Goldanskii, V. I.; Makarov, E. F.; Suzdalev, I. P.; Vinogradov, I. A. (Inst. of Chemical Physics, Moscow). Phys. Rev. Lett., 20: 137-40(Jan. 22, 1968).

The comparison of quadrupole doublets of Mössbauer spectra for monocrystals of siderite at various orientation angles and those for polycrystalline siderite gives quantitative proof of the vibrational anisotropy origin of integral asymmetry of doublets in polycrystals. Such comparison has also been used for determination of the absolute probability of the Mössbauer effect and of the sign of the electric-field gradient on iron nuclei in siderite (which was found to be positive). (auth)

11533 FREQUENCY SPECTRUM AND THE MOESSBAUER EFFECT IN THIN FILMS. Corciovei, A.; Grecu, D.; Radescu, E. (Inst. of Atomic Physics, Bucharest). Z. Phys., 209: 134-56 (1968).

A theoretical study was made of thermal vibrations and the Mössbauer effect in a cubic thin film. The frequency spectrum determined in the first neighbor approximation, was used to calculate the Debye–Waller factor, as a function of the film thickness, temperature and force constants. The main peculiarity of the phenomenon is the appearance in the recoilless fraction of an anisotropy with respect to the angle θ between the normal to the film surface and the direction of the emitted (or absorbed) gamma quanta. For a film with q monoatomic layers the Debye–Waller factor is given by the expression $f(q) = f(\infty)\, e_{\lambda\mu}\, \{c(q)[1 + D(q)\cos^2\theta]\}$, where $f(\infty)$ is the bulk-body value. To obtain this compact analytical expression for $f(q)$ the appearing sums over q modes of vibration were transformed into integrals, using the well-known Euler's transformation relation. Then the main q-dependence of $c(q)$ and $D(q)$ is $c(q) = 1 + c_1(T,\lambda)/q$, $D(q) = D_1(T,\lambda)/q$ where λ denotes the ratio between transverse and longitudinal components of the force constant tensor. Although an analytic expression was obtained for the general case, an explicit temperature dependence was made obvious only for low and high temperatures. It was also

pointed out that for a correct mathematical treatment of the problem the presence of the support with its surface conditions, was compulsory. (auth)

11534 HYPERFINE STRUCTURE MEASUREMENTS ON ANHYDROUS IRON HALIDES WITH THE MOESSBAUER EFFECT. Pfletschinger, Elmar (Technische Hochschule, Munich). Z. Phys., 209: 119-33(1968). (In German).

Mössbauer effect measurements were performed with the anhydrous iron halides $FeCl_2$, $FeBr_2$ and FeI_2 at 78°K and 4°K and with $FeCl_3$ at 4°K. The quadrupole splitting, the isomer shift and the magnetic field at the nucleus were determined. From the quadrupole splitting it follows that in $FeCl_2$, $FeBr_2$ and FeI_2 the ground state is a doublet and that the singlet in these compounds is separated from it by (145 ± 35) cm^{-1}, (175 ± 35) cm^{-1} and (135 ± 35) cm^{-1} respectively. The isomer shift shows the presence of strong covalence effects in all compounds. The large isomer shift in $FeBr_3$ cannot be fully explained. From the isomer shift and the magnetic field at the nucleus in $FeCl_3$ it can be concluded that the Fe^{+++} ions has an $3d^{5,6}\ 4s^{0,45}$ configuration. In $FeCl_2$, $FeBr_2$ and FeI_2 the smallness of the magnetic field can be explained by a not fully quenched orbital angular momentum of $0.6 < L_z < 1$. (auth)

11535 HYPERFINE FIELDS ON RECOIL IMPLANTED NUCLEI $62 \leq Z \leq 74$ IN A POLARIZED Fe-, Co-, and Ni-ENVIRONMENT. Brenn, R.; Lehmann, L.; Spehl, H. (Univ., Frieburg i.B.). Z. Phys., 209: 197-207(1968).

Hyperfine fields acting on Sm, Gd, Dy, Er, Yb, Hf, and W nuclei in a polarized ferromagnetic environment of Fe, Co, and Ni have been investigated. The nuclei have been implanted into the host lattice by the recoil associated with Coulomb excitation with 11-MeV ^{12}C-ions from a 5.5-MV Van de Graaff accelerator. The precession of the γ-ray angular distribution has been measured and substantial perturbations were found. It is shown that the perturbation, at least for the case of the strongly perturbed rare earth nuclei, cannot be explained by a combined static electric quadrupole and magnetic dipole interaction. (auth)

11536 A COMPARISON OF THE HOT IMPLANTATION BEHAVIOR OF SEVERAL GROUP-III AND -V ELEMENTS IN Si AND Ge. Mayer, J. W.; Davies, J. A.; Eriksson, L. (Chalk River Nuclear Labs., Ont.). Appl. Phys. Lett., 11: 365-7(Dec. 15, 1967).

The orientation dependence of the backscattered yield of 1.0-MeV helium ions has been used to determine the lattice location of several group-III and group-V elements implanted at elevated temperatures in Si and Ge. We find that for the slower diffusants, i.e., group-V elements in Si and group III in Ge, a considerably higher fraction is located on substitutional sites than for the faster diffusants. The concentration of Sb and Bi on substitutional lattice sites can exceed the equilibrium solubility by at least an order of magnitude. For In and Tl in Si, we find equal numbers of ions on the ⟨111⟩ interstitial lattice sites and on the substitutional lattice sites which suggest that some sort of pairing occurs between interstitial and substitutional impurities; again, the substitutional content can exceed the equilibrium solubility limit by large factors. (auth)

11537 CHANNELING OF MeV PROJECTILES IN TUNGSTEN AND SILICON. Davies, J. A.; Denhartog, J.; Whitton, J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev., 165: 345-56(Jan. 10, 1968).

Wide-angle Rutherford scattering has been used to investigate experimentally the channeling behavior of several projectiles (^1H, ^4He, ^{12}C, ^{16}O, and ^{35}Cl) in tungsten crystals in the energy region 2 to 30 MeV; the study has also been extended to silicon crystals, using a 3.0-MeV ^1H beam. The observed critical angles and minimum scattering yields are compared with theoretical predictions. In general, the agreement is excellent. In both W and Si, precise energy analysis of the scattered beam has also provided detailed information on the depth and temperature dependence of channeling; a marked difference is observed between the planar and axial channeling processes. Some preliminary measurements in Au and UO_2 crystals are included. (auth)

11538 RANGE OF Ar, Kr, AND Xe IONS IN SOLIDS IN THE 500-keV TO 2-MeV ENERGY REGION. Powers, D.; Chu, W. K.; Bourland, P. D. (Baylor Univ., Waco, Tex.). Phys. Rev., 165: 376-87(Jan. 10, 1968).

The range of Ar in Be and C, of Kr in Be, C, and Al, and of Xe in Be, C, and Al has been measured in 100-keV steps from 500 keV to 2 MeV with an accuracy varying from ±10.1 to 3.2%. The range of Xe in V, Ni, and Cu has been measured in 250-keV steps from 500 keV to 1.75 MeV with an accuracy of ±11.4 to 5.7%. Seven of the 11 sets of measurements agree to within 9% of the theory due to Lindhard, Scharff, and Schiøtt, with the best agreement in the energy region where electronic stopping is roughly equal to nuclear stopping. The measurements on Ar in Be and C are lower than the theory by 10 to 18% until a shell-structure correction of Ormrod, MacDonald, and Duckworth is applied, and then excellent agreement is obtained. The measurements on Xe in Ni and Cu are lower than the theory by 8 to 24%. Proton-stopping cross sections in V at 559, 1776, and 1984 keV are reported. (auth)

11539 MODEL FOR KINETIC ELECTRON EJECTION FROM GAS-COVERED SURFACES. Trolinger, James D. (ARO, Inc., Arnold Air Force Station, Tenn.). Phys. Rev., 165: 388-91 (Jan. 10, 1968).

A model for the ionization of molecules adsorbed to a surface by energetic ion bombardment is described. The transition of a hypothetical "average" ion to the surface through a low-density surface gas is analyzed and assumed to represent the ensemble of collision processes encountered in the real case. This leads to the determination of the probability of freeing an electron from an atom in the surface gas by an impinging ion. For surfaces with a monolayer or more of adsorbate, the probability is comparable in size to coefficients of potential and kinetic ejection for ion kinetic energies above 1000 eV. (auth)

11540 NUCLEAR MAGNETIC RESONANCE AND QUADRUPOLE EFFECTS IN KBr AND NaBr SINGLE CRYSTALS. Bonera, G.; Avogadro, A.; Borsa, F. (CNR, Pavia, Italy. Univ., Pavia, Italy). Phys. Rev., 165: 391-6(Jan. 10, 1968).

Nuclear-magnetic-resonance pulse techniques have been applied to the study of first-order quadrupole broadening of the satellites for the bromine nucleus in alkali halide crystals. From the analysis of the free precession, the shape and the width of the satellite line can be obtained. For KBr and NaBr it has been found that the satellite line has a Lorentz shape, and that the width depends upon the orientation of the applied magnetic field. Also it is shown that by continuous-wave measurements the broadening of the satellites can be detected from measurements of the effective saturation relaxation time. The results obtained are discussed in relation to the type and orientation of dislocations present in the crystals. (auth)

11541 MOESSBAUER STUDY OF TWO Pd–Fe ALLOYS CONTAINING ABSORBED HYDROGEN. Phillips, Walter C. (Argonne National Lab., Ill. Electronics Research Center, Cambridge, Mass.); Kimball, Clyde W. Phys. Rev., 165: 401-6 (Jan. 10, 1968).

The temperature dependence of hyperfine fields and isomer shifts in the system Pd–Fe–H (2 and 5% Fe) has been investigated by means of the ^{57}Fe Mössbauer effect. Hyperfine fields indicating that an ordered magnetic structure exists in the β phase at H concentrations high enough to cause filling of the Pd 4d band (H/Pd ≥ 0.59 for 2% Fe) were observed. The β-phase transition temperature $T_c(\beta)$ is considerably lower than the corresponding α-phase transition temperature. For the 2%-Fe alloy, $T_c(\beta) = (3 \pm 1)°K$ and $H(1.8°K) \approx 240$ kOe; for the 5%-Fe alloy, $T_c(\beta) = (10 \pm 3)°K$ and $H(1.8°K) \approx 310$ kOe. The distribution of measured hyperfine fields has been correlated with the H near-neighbor configuration. Above $T_c(\alpha)$ and also below $T_c(\beta)$, an isomer shift of +0.045 ± 0.003 mm/sec was observed in going from the α to the β phase. (auth)

11542 ANISOTROPIC LATTICE-DYNAMIC STUDIES AND LINE ASYMMETRIES IN MOESSBAUER-EFFECT DOUBLET SPECTRA. Stockler, Hans A. (National Lead Co., Hightstown, N. J.); Sano, Hirotoshi. Phys. Rev., 165: 406-8(Jan. 10, 1968).

Asymmetries in the line intensities of component lines of electric-quadrupole doublets in Mössbauer spectra (the Karyagin effect) have been observed in linear chain-polycrystalline polymers over a wide range of temperatures. It was observed that the asymmetry increases at higher temperatures and almost disappears at low temperatures. No significant Karyagin effect has been observed for three-dimensional monomeric material. (auth)

11543 STOPPING CROSS SECTION IN CARBON OF 0.2- TO 1.5-MeV ATOMS WITH $21 \leq Z_1 \leq 39$. Hvelplund, P; Fastrup, B. (Univ. Aarhus, Denmark). Phys. Rev., 165: 408-14(Jan. 10, 1968).

The stopping cross section $S = d\ E/Nd\ R$ in thin carbon foils has been measured for ions with $21 \leq Z_1 \leq 39$ and with energies from 200 to 1500 keV. The experimental data have been corrected numerically for nuclear stopping, and the electronic stopping obtained is compared with theory. At constant projectile velocity, the periodic dependence of the electronic stopping cross section on the atomic number Z_1 of the incoming ions, previously reported for $Z_1 \leq 20$, is seen also in the present extended Z_1 range. The data show that the amplitude of the successive oscillations is approximately constant over the whole Z_1 range. The relative amplitude, however, tends to decrease with increasing velocity. The relative accuracy of the results is about 3%. (auth)

11544 ENERGY LOSS BY LOW-ENERGY PROTONS IN GOLD. Morton, A. H.; Aldcroft, D. A.; Payne, M. F. (Culham Lab., Abingdon, Eng.). Phys. Rev., 165: 415-19(Jan. 10, 1968).

An experiment employing a new method of measuring stopping power at low energies is described, and results are given for protons on gold. Values of dE/dx for protons on gold have been obtained from measurements of the response of a silicon surface-barrier detector, covered with a surface layer of gold, to protons of energy below 50 keV. The response of the detector to H_2^+ and H_3^+ ions in the same energy range has been used to determine backscattering cross sections for protons on gold. (auth)

11545 MOESSBAUER SPECTRA IN A FLUCTUATING ENVIRONMENT. Blume, M.; Tjon, J. A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 165: 446-56(Jan. 10, 1968). (BNL-11654).

The Mössbauer line shape in the presence of time-dependent electric field gradients and magnetic fields is considered. Two specific soluble stochastic models are treated: (1) a static electric field gradient with a randomly fluctuating magnetic field that takes on values +h and −h, each directed along the axis of the field gradient, and (2) as in (1), but with the fluctuating magnetic field perpendicular to the axis of the field gradient. Example (2) is more complex than (1), since the fluctuating field is in this case capable of inducing transitions between the nuclear levels, while in (1) this is not possible. Specific calculations for the two cases illustrate the differences between them. (auth)

11546 MOESSBAUER SPECTRA IN A FLUCTUATING ENVIRONMENT. II. RANDOMLY VARYING ELECTRIC FIELD GRADIENTS. Tjon, J. A.; Blume, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 165: 456-61(Jan. 10, 1968). (BNL-11655).

An expression is derived for the Mössbauer line shape in the presence of an electric field gradient that jumps at random between the x, y, and z axes. This Hamiltonian represents an idealized model for the effects on a nucleus of Jahn–Teller distortions, jump diffusion of vacancies, or electronic relaxation. A simplified calculation based on a model in which the field gradient jumps between positive and negative values along the z axis is also given. In certain limiting circumstances the two calculations give similar results: the Mössbauer line shape consists of a single unsplit line for fast jumping and of a quadrupole doublet for slow transitions. The results of the calculation agree with experiments of Pipkorn and Leider and of Chappert, Frankel, and Blum, as interpreted by Ham. (auth)

11547 FLUCTUATIONS OF ENERGY LOSS BY HEAVY CHARGED PARTICLES IN THIN ABSORBERS. Maccabee, H. D.; Raju, M. R.; Tobias, C. A. (Univ. of California, Berkeley). Phys. Rev., 165: 469-74(Jan. 10, 1968). (UCRL-17714).

Significant fluctuations of energy loss are expected in certain cases of the passage of fast heavy charged particles through thin absorbers. When the number of particle–electron collisions in the upper collision-loss interval is small, the energy-loss distribution is asymmetric and is characterized by a broad peak around the most probable energy loss (which is significantly less than the mean energy loss) and by a high-energy-loss tail. Several theories predict the energy-loss distribution function, but previous experimental work is incomplete with respect to verification of theory over the whole significant range of the parameters involved. Beams of 730- and 45-MeV protons, 910-MeV helium ions, and 370-MeV π^- mesons were passed through lithium-drifted silicon p–i–n detectors and silicon p–n junction detectors with depletion layers from 0.0085 to 1.094 g/cm^2, and the resulting energy-loss distributions were measured. Within the limits of experimental error, there is very good agreement between the measured energy-loss distributions and those predicted by Vavilov's theory, and good agreement on the value of the most probable energy loss. (auth)

11548 CHANNELING OF H^+, D^+, AND $^3He^{2+}$ IONS IN GERMANIUM: A DIFFRACTION CALCULATION. Brice, David K. (Sandia Lab., Albuquerque, N. M.). Phys. Rev., 165: 475-84 (Jan. 10, 1968).

The channeling properties of H^+, D^+, and $^3He^{2+}$ ions in germanium have been examined, using a diffraction model for the interaction between the lattice and the channeled ions. The stopping power ($-dE/dx$) and the differential mean-square energy spread ($d\sigma^2/dE$) of the channeling energy spectrum have been calculated for each of the above ions in the energy range 3 to 8 MeV for three incident directions in the lattice. The energy states of the electrons in the lattice are approximated by using a shell model of the lattice atoms. Z electrons per atom are assumed to occupy a rigid, negatively charged shell surrounding an atomic core, where Z is an adjustable parameter in the calculation. An harmonic approximation to the shell–core and shell–shell interactions in the lattice then leads to phononlike excitations in which the shell and atomic core are moving out of phase. This introduces a time-dependent polarization in the lattice, which interacts strongly with the incident ions. The lower-energy portion of this excitation spectrum is identified with the plasmon spectrum of the solid, and the known properties of the plasmons are included in the calculation. The parameter Z is adjusted to give agreement between the theoretical and experimental channeling energy losses. No experimental data are presently available for comparison with the calculations for $^3He^{2+}$. The results indicate that each of the three directions considered in the calculations can be characterized by a reasonable value of Z, which is expected to be $\gtrsim 4$ depending on the degree to which the valence electrons shielded the inner electrons. For ions incident near the directions indicated these values are ⟨1, 1, 0⟩, Z = 5.6 ± 0.3; ⟨1, 1, 1⟩, Z = 8.6 ± 0.4; ⟨1, 1, 2⟩, Z = 7.2 ± 0.3. (auth)

11549 MOESSBAUER EFFECT IN MgO:Fe^{+2}; LOW-TEMPERATURE QUADRUPOLE SPLITTING. Leider, H. R.; Pipkorn; D. N. (Univ. of California, Livermore). Phys. Rev., 165: 494-500(Jan. 10, 1968).

Mössbauer spectra of absorbers of Fe^{+2} in MgO have been measured from room temperature (RT) down to liquid–helium temperature. At the higher temperatures, the spectrum consists of a single narrow peak (Γ = 0.25 mm/sec at RT). Below 20°K, the absorption peak becomes broader and non-Lorentzian, and finally resolves into a close quadrupole doublet, ΔE = 0.33 mm/sec. This splitting arises from the combined effect of random strains that lift the degeneracy of the ground state, and relaxation between the ground levels by an Orbach process through the next higher spin-orbit level. The exponential dependence of the relaxation frequencies derived from the spectra is characterized by a value of Δ = 93 cm^{-1}. Measurements in a large applied field agree with predictions of the random-strain model. (auth)

11550 HYPERFINE FIELDS AND ELECTRONIC STRUCTURE OF CsCl-TYPE TERNARY ALLOYS OF THE FIRST TRANSITION SERIES. Bennett, Lawrence H. (National Bureau of Standards, Gaithersburg, Md.); Swartzendruber, L. J.; Watson, R. E. Phys. Rev., 165: 500-5(Jan. 10, 1968). (BNL-11523).

The ^{59}Co Knight shift K and the ^{57}Fe isomer shift have been measured in $TiFe_{1-x}Co_x$ alloys over most of the composition range $0 \leq x \leq 1$. The experimental results are discussed in terms of correlations with electron concentration and s admixture in the d bands. At room temperature, K varies from a maximum of (3.2 ± 0.2)% at $x \approx 0.8$, and roughly follows the electronic specific heat as the composition is varied, with a minimum of K = (0.8 ± 0.2)% near x = 0. K increases substantially as the temperature is lowered for x near 1, and decreases somewhat for x near 0. The maximum K measured is (4.7 ± 0.2)% for $x \approx 0.8$ at 120°K. The slopes of K versus susceptibility vary from +86 kG/μ_B per formula unit for x = 0.8 to −47 kG/μ_B per formula unit for x = 0.05. The isomer-shift variation, from −0.15 ± 0.01 (mm/sec relative to pure Fe) at TiFe to −0.19 ± 0.02 at TiCo, is similar to that of Fe in Cr–Mn. The ^{47,49}Ti Knight shift in TiFe is (0.26 ± 0.04)% at room and at liquid-nitrogen temperatures. (auth)

11551 NUCLEAR MAGNETIC RESONANCE AND RELAXATION IN IRIDIUM METAL: THE NUCLEAR MAGNETIC DIPOLE MOMENTS OF ^{191}Ir AND ^{193}Ir. Narath, Albert (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 165: 506-11(Jan. 10, 1968).

The nuclear magnetic resonances of ^{191}Ir and ^{193}Ir have been detected by pulsed NMR techniques in iridium metal in the temperature range T = 1 to 4°K and in external magnetic fields between 50 and 60 kOe. The observed frequency–field ratios for these isotopes are $\nu^{(191)}/H$ = 0.074127(18) kHz/Oe and $\nu^{(193)}/H$ = 0.080725(6) kHz/Oe. By combining the measured spin–lattice relaxation times $T_1^{(193)}T = 2.8 \pm 0.2$ sec°K with known values of the magnetic susceptibility and electronic specific heat, the Knight shift in iridium metal is estimated to be K = +(1.3 ± 0.4)%. Applying this shift to the experimental frequency–field ratios yields the nuclear magnetic dipole moments (uncorrected for diamagnetic shifts) $\mu^{(191)} = 0.1440(6)\mu_N$ and $\mu^{(193)} = 0.1568(6)\mu_N$. (auth)

11552 MAGNETIC SUSCEPTIBILITY OF SINGLE-CRYSTAL ALPHA-URANIUM. Ross, J. W.; Lam, D. J. (Argonne National Lab., Ill.). Phys. Rev., 165: 617-20(Jan. 10, 1968).

The magnetic susceptibility of high-purity single-crystal α uranium has been measured from 4 to 300°K. A different temperature dependence was observed in each of the three principal crystallographic axes, and changes in slope were also noted below 40°K. The results are discussed in terms of localization of 5f electrons, spin-density waves, or Brillouin-zone–Fermi-surface interplay. (auth)

11553 EFFECT OF THE MAGNETIC STRUCTURES OF HOLMIUM METAL ON THE ABSORPTION SPECTRUM OF 3-mm MICROWAVE RADIATION. Stanford, John L. (Ames Lab., Iowa). Phys. Rev., 165: 642-6(Jan. 10, 1968). (IS-1659).

The absorption of 3-mm (100-GHz) microwave radiation has been studied in single-crystal holmium metal from 4 to 80°K in applied magnetic fields up to 26 kOe. A variety of absorption spectra (as a function of applied field) were observed and correlated with the complicated magnetic structures of metallic holmium. Sharp absorption peaks of strong intensity were observed at helical-fan and fan-fan field-induced phase transitions. Anisotropy studies in the 50 to 60°K range revealed only small anisotropy between "easy" ($[10\bar{1}0]$) and "hard" ($[11\bar{2}0]$) directions of magnetization, in contrast with published results based on neutron-diffraction studies, but in agreement with magnetization and magnetoresistance data for holmium. The absorption was found to be independent of the relative polarization of H_{rf} with respect to H_{dc}, suggesting that it is characteristic purely of magnetic domain and phase effects. The zero-wave-number spin-wave resonances predicted for the heavy rare earth metals by Cooper and Elliott were not observed, and it is shown that this is in agreement with the two- and sixfold anisotropy-constant calculations by Kasuya and a consideration of the sequence of field-induced magnetic phases of holmium. No evidence of a resonance in the helical antiferromagnetic phase was observed, in agreement with the prediction of Cooper and Elliott. The absorption of microwave power was found to be a sensitive method for detection of magnetic phase transitions, in some cases being much more sensitive than magnetization or magnetoresistance techniques. (auth)

11554 NEUTRON-DIFFRACTION STUDY OF Tb AND Ho UNDER HIGH PRESSURE. Umebayashi, H. (Brookhaven National Lab., Upton, N. Y.); Shirane, G.; Frazer, B. C.; Daniels, W. B. Phys. Rev., 165: 688-92(Jan. 10, 1968).

The pressure dependence of the helical turn angle ω of Tb and Ho single crystals was measured by neutron diffraction up to 6 kbar at temperatures above 80°K. At constant $T - T_N$, the relative changes of ω with pressure $(1/\omega)d\omega/dp$ were slightly temperature-dependent, but representative average values were 20×10^{-3}/kbar for Tb and 1.2×10^{-3}/kbar for Ho. These values were explained satisfactorily by a calculation based on Miwa's theory. The values for the pressure coefficients of the Néel temperature of Tb and Ho, as well as of the ferromagnetic transition temperature of Tb, were also obtained and were in reasonable agreement with the reported values. The spiral temperature range in Tb was found to increase with pressure at the rate of 0.3 ± 0.12°K/kbar. (auth)

11555 NEUTRON-DIFFRACTION STUDY OF THE MAGNETIC BEHAVIOR OF GADOLINIUM. Cable, J. W.; Wollan, E. O. (Oak Ridge National Lab., Tenn.). Phys. Rev., 165: 733-34(Jan. 10, 1968). (ORNL-P-3398).

Neutron-diffraction measurements were made on a single crystal of gadolinium at sample temperatures from 10 to 350°K to investigate the possible occurrence of a spiral spin structure. The measurements show that Gd is a normal ferromagnet with a rather complex temperature dependence of the spontaneous moment alignment. Between T_C = 294 and 232°K the moment is parallel to the c axis; below 232°K it moves away from the c axis to a maximum deviation of about 65° near 180°K and then back to within 32° of the c axis at low temperatures. (auth)

11556 SIMULTANEOUS PARALLEL PUMPING OF NUCLEAR AND ELECTRONIC SPIN WAVES. Ninio, F.; Keffer, F. (Univ. of Pittsburgh). Phys. Rev., 165: 735-50(Jan. 10, 1968).

In a magnetic medium in which the nuclei carry a magnetic moment, there exists a spectrum of nuclear spin waves in addition to the usual electronic spin waves, provided the temperature is sufficiently low. The possibility is investigated of joint excitation of nuclear and electronic magnons by parallel pumping; this process is analogous to "exchange pumping" of acoustic and exchange magnons in a ferrimagnet. First a simple ferromagnet is considered, then the ferrimagnet manganese ferrite, and finally the cubic antiferromagnet $RbMnF_3$. It is suggested that the process should be feasible, and that it should be possible thereby to excite nuclear spin waves of arbitrary k. (In ordinary NMR only k = 0 is excited.) The threshold pump field in a typical material is estimated to be of order 36 Oe in magnitude, but it can be smaller in carefully prepared samples. (auth)

11557 PHOTOELECTRONIC PROPERTIES OF ZnS SINGLE CRYSTALS WITH IMPERFECTIONS INDUCED BY ANNEALING OR BY RADIOACTIVE IMPURITIES. Blount, George Herbert. Stanford, Calif., Stanford Univ., 1967. 136p.

Thesis.

Native defects were introduced by annealing in Zn or S vapor for periods from 20 minutes to 6 days. Chlorine impurity was introduced either in the crystal growth process itself, or through the radioactive decay of ^{35}S incorporated during crystal growth, or by diffusion. Insensitive, insulating, nonluminescent crystals of pure ZnS were annealed for various periods of time at 891°C in a saturated Zn vapor. Annealing increases the dark conductivity by at least eight orders of magnitude, the photosensitivity by over three orders of magnitude, and produces appreciable changes in the luminescence emission. The effects of annealing in Zn vapor are reversed by subsequently annealing in S vapor. Optical quenching data show that the high photosensitivity in the annealed crystals is associated with sensitizing centers lying 1.2 eV above the valence band (with an additional excited-state transition of 0.97 eV). The electron capture cross section of these centers is 10^{-21} cm^2. The photosensitivity of all crystals decreases rapidly with decreasing temperature near 77°K, but this effect is particularly strong in the Zn-annealed crystals. The effect is found regardless of whether photoexcitation is across the band gap or by infrared radiation from 0.65 eV trapping levels. A consideration of all the data available indicates that the observed decrease in photosensitivity at low temperatures is caused by the depletion of electrons in absorption centers as electrons are transferred to traps. Radioactive ^{35}S was incorporated into ZnS crystals, either by being present during the growth or by diffusion into pure insulating crystals. (In the course of the latter work, the self-diffusion of sulfur in ZnS was measured as a function of temperature; the activation energy was found to be about 3.4 eV.) Increasing the donor concentration by 10^{15} atoms cm^{-3} through the decay of radioactive ^{35}S does not increase the dark conductivity of insulating crystals above the initial value corresponding to 10^7 free electrons cm^{-3}. The decay of ^{35}S appears to be correlated with an increase in the intensity of the self-activated photoluminescence band. Suitable defect models for the observed effects are considered and discussed. (Diss. Abstr.)

11558 LARGE-ANGLE ELASTIC SCATTERING OF ENERGETIC PROTONS IN SILICON SINGLE CRYSTALS. Feldman, Leonard Cecil. New Brunswick, N. J., Rutgers–The State Univ., 1967. 202p.

Thesis.

Large-angle elastic scattering of protons of MeV energies from silicon single crystals was studied. In general, the ordered arrangement of the nuclei that exists in a single crystal is shown to have a large effect on the elastic scattering yields (as compared to an amorphous target with the same number of scattering centers) when certain angular relations are satisfied among the incident beam direction, the scattering direction, and low-index crystalline directions. Experiments in which the incident beam is parallel to a principal direction of the crystal (channeling) and investigations in which the scattered particle emerges parallel to a principal direction (blocking) are analyzed and discussed. (TSS) (Diss. Abstr.)

11559 SIMULTANEOUS PRODUCTION AND BLEACHING OF F CENTERS. Covault, Dennis Owen. Lincoln, Nebr., Univ. of Nebraska, 1967. 82p.

Thesis.

It has been found that simultaneous irradiation with x rays and light in the neighborhood of room temperature causes a super recovery of the F band upon subsequent x irradiation in the dark, in all KCl crystals tried except for the very pure and the very impure. That is, the F-band growth obtained in the above manner surpasses that of a companion crystal x-rayed only in the dark. The portion of the bleaching spectrum responsible is the F band. This super recovery was not found at liquid nitrogen temperature in KCl or in other alkali halides at room temperature. It was found to increase monotonically with the F-band bleaching intensity to a saturation value. It was also found to be a strong function of the irradiation temperature. There is some evidence from optical bleaching that the F centers in the crystals which were simultaneously x-rayed and bleached differ from those in the crystals which were x-rayed only. Attempts to theoretically explain these results have been unsuccessful. (Diss. Abstr.)

11560 ION-INDUCED ELECTRON EJECTION FROM SURFACES IN CONTROLLED STATES OF CONTAMINATION. Trolinger, James Davis. Knoxville, Tenn., Univ. of Tennessee, 1967. 170p.

Thesis.

A review and analysis of experimental and theoretical work in the field of ion-induced kinetic and potential electron ejection from material surfaces is presented. A model for the electron ejection from gas-coated surfaces is constructed and analyzed. The analysis leads to an expression for the electron ejection from gas-coated surfaces, which predicts, without adjustment parameters, the dependence of electron emission on ion energy, on the properties of the ion and adsorbed gas, and on the number of monolayers of adsorbed gas. An experimental study of the

bombardment of molybdenum by He^+, Ne^+, Ar^+, and N_2^+ in its clean state and in a state of contamination by the same gases is reported, and results correlate well with the theory presented. (Disser. Abstr.)

11561 MOESSBAUER GAMMA-RAY DIFFRACTION. **Hannon, James Patrick. Houston, Tex., Rice Univ., 1967. 115p.**

Thesis.

Using the Feynman techniques of quantum electrodynamics, the theory of the interaction of Moessbauer γ rays with crystals containing the resonant nuclei is developed. The optics of the 14.4-keV ^{57}Fe γ ray has been developed in detail, account being taken of the interference of the electronic and nuclear scattering, the Zeeman splittings of the nuclear levels, and the effect of virtual photon–phonon exchanges between the scatterers. The dynamic theory of Bragg reflection, Bormann transmission, and grazing incidence from Moessbauer crystals is worked out. Some novel magneto-optical properties are obtained for ferromagnetic and antiferromagnetic crystals. The theory is applied to the analysis of the available experiments. (Disser. Abstr.)

11562 ^{133}Xe DIFFUSION IN SINGLE-CRYSTAL CESIUM-IODIDE. **Christman, Ronald Peter. Raleigh, N. C., North Carolina State of the Univ. of North Carolina, 1967. 75p.**

Thesis.

The diffusion characteristics of the fission rare gas ^{133}Xe in cesium-iodide single crystals are examined employing a new gas-doping technique. Cesium-iodide crystals are grown from melts containing ^{133}I-tagged cesium iodide whose first daughter product is ^{133}Xe. The method yields an initially homogeneous gas atom distribution in the absence of radiation damage. It permits the separation of gas atom concentration effects and radiation damage effects previously not possible with other doping procedures. Comparisons are made with crystals tagged by conventional fast neutron irradiation. Gas releases are measured using a continuous radioassay apparatus for annealing periods up to four days. The results verify classical predictions in the instances where crystalline growth defect concentrations are low. Crystals containing localized defects causing crystal opacity exhibit a burst release pattern similar to those observed in uranium dioxide. Diffusion coefficient data indicate that the burst is the true diffusional portion for these crystals. Storage in varying environmental conditions does not produce deviations from classical releases. An activation energy of 23 kcal/mole and a characteristic diffusion coefficient of 0.075 cm^2/sec are calculated. Evidence for a divacancy diffusion mechanism is presented. Fast neutron-tagged crystals exhibit a degradation in diffusion coefficient indicating the dose dependence of coefficients determined from this type of doping method. A trapping mechanism is suggested to explain the deviation. Hurst's (1962) method is applied to the release data of calculate trapping site concentrations and gas atom retention time. A correlation is made with the ^{133}Xe recoil spike concentration to support this assumption. (Disser. Abstr.)

Theoretical Physics

11563 (IPNO/TH–92) RENORMALIZATION AND THE CLASSICAL ELECTROMAGNETIC ONE-BODY PROBLEM FOR AN EXTENDED BODY. **Arnous, E. (Paris Univ., Orsay (France). Institut de Physique Nucleaire); Madore, J.; Papapetrou, A. (Paris Univ. (France). Institut Henri Poincare). June 1967. 9p. Dep.**

A decomposition of the Maxwell stress–energy tensor into two terms is proposed corresponding to the decomposition of the electromagnetic force into radiative and nonradiative parts given by Dirac. This permits the nonradiative force to be expressed as the divergence of a nonradiative tensor. This tensor is added to the matter tensor to form the total or renormalized matter tensor. (auth)

11564 MANY-BODY PROBLEM IN QUANTUM MECHANICS. **March, N. H.; Young, W. H.; Sampanthar, S. Cambridge Monographs on Physics. New York, Cambridge University Press, 1967. 468p. $14.50.**

The purpose of this book is to present, as simply as possible in what is intrinsically a difficult subject, a detailed account of the more important methods which have been worked out for tackling problems involving the interactions of many bodies. The book aims to introduce graduate students to the concepts, language, and techniques used by research workers in the field. (W.D.M.)

11565 PHYSICS OF MANY-PARTICLE SYSTEMS: METHODS AND PROBLEMS. VOLUME 1. **Meeron, Emmanuel (ed.). New York, Gordon and Breach, Science Publishers, Inc., 1966. 695p. $39.50 Reference Edition, $24.50 Professional Edition.**

Material is included on: the techniques of high-speed computer experiments, an introduction to lattice dynamics in the harmonic approximation, statistical mechanics of the Heisenberg ferromagnet, dynamics of interacting bosons, group theory and the many-body problem, a perturbative approach to irreversible statistical mechanics, and nonequilibrium phenomena in stellar atmospheres. (M.H.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

11566 SEARCH FOR MASSIVE PARTICLES IN COSMIC RAYS. Jones, Lawrence W. (Univ. of Michigan, Ann Arbor); Lyon, D. E. Jr.; Ramana Murthy, P. V. (and others). Contract Nonr. 1224(23). Phys. Rev., 164: 1584-94(Dec. 25, 1967).

A search for heavy particles with a mass greater than that of a nucleon, the existence of which has been suggested by higher-symmetry schemes, was performed with an apparatus set up at Echo Lake, Colorado (elevation 10,600 ft). The search was sensitive to strongly interacting particles with masses in the range 5–15 BeV, with no restriction imposed on their electric charge. The method used was to measure the time interval between the arrival of strongly interacting particles and accompanying air shower particles. This information, coupled with information from a measurement of the particle's energy and range of absorption in a total absorption spectrometer, enabled a distinction to be made between massive elementary particles, nucleons, and nuclei. In an operating period of 1542 h and with an aperture of 0.78 m^2 sr, one delayed event was found whose behavior in the total absorption spectrometer was atypical of a nucleon or nucleus. If one considers this event to represent the arrival of a massive particle, then its mass, calculated assuming that its production occurred 1 km above the apparatus, is approximately 6.5 BeV. This one event corresponds to a flux of the order of 10^{-10} $(cm^2\ sec\ sr)^{-1}$, where a correction for detection efficiency has been included. As there is also an 8% probability that this event was a nucleon, we do not regard this as significant evidence for the existence of a massive elementary particle, but rather as setting an effective upper limit to the flux of such particles. (auth)

Electromagnetic

Refer also to abstracts 11826 and 11828.

11567 (DESY-67/31) ELECTROPRODUCTION OF PIONS. Blechschmidt, H.; Dowd, J. P.; Elsner, B.; Heinloth, K.; Karow, P.; Rathje, J.; Schmidt, D.; Smith, J. H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany); Kanaris, A.; Wynroe, A. G. (Manchester Univ. (England)). Oct. 1967. 12p. Dep.

A spark chamber experiment performed at the virtual photon energy from 0.7 to 3 GeV is reported. Electroproduction of single positive mesons (π) on hydrogen in the reaction $e + p \rightarrow e' + \pi^+ + n$ was measured detecting the scattered electron and produced meson (π) in coincidence. Also positive or negative mesons (π) from multiple meson (π) production in $e + p \rightarrow e' + \pi^+(\pi^-) + (N + \pi + \ldots)$ reactions were detected. The missing mass spectra from the second reaction was plotted for both positive and negative meson (π) production in intervals of the virtual photon energy. It is seen that the main contribution to multiple meson (π) production is due to ρ^0 production. The distribution of four-momentum squared of the virtual photon for the single-meson (π) events is also shown in three energy intervals. Finally, the cross section for electroproduction is shown as a function of the four-momentum transfer to the nucleon. (J.F.P.)

11568 (SLAC-PUB-370) ELECTROMAGNETIC INTERACTIONS. Panofsky, W. K. H. (Stanford Linear Accelerator Center, Calif.). [1967]. Contract AT(04-3)-515. 57p. (CONF-670934-9). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

The review of experimental interactions includes recent results of pure quantum electrodynamics and also processes involving hadrons and electromagnetic interactions combined. Hadron properties examined by electromagnetic processes, including electron scattering, and high-energy photoproduction of hadrons, with restriction made to the nonresonant region, are considered. (J.F.P.)

11569 (SLAC-PUB-372) NUCLEON FORM FACTORS ABOVE 6 GeV. Taylor, R. E. (Stanford Linear Accelerator Center, Calif.). Sept. 1967. Contract AT(04-3)-515. 24p. (CONF-670923-4). Dep. CFSTI.

From 3rd International Symposium on Electron and Photon Interactions at High Energies, Stanford, Calif.

Results from a preliminary analysis of an elastic electron–proton scattering experiment are described. The cross sections for e + p scattering were measured in the range from 0.7 to 25.0 $(GeV/c)^2$. The cross section was measured by observing electrons scattered from a beam passing through a liquid hydrogen target. The scattered particles were momentum-analyzed by a magnetic spectrometer and identified as electrons in a total-absorption shower counter. Data were obtained with primary electron energies from 4.0 to 17.8 GeV and at scattering angles from 12.5 to 35.0 degrees. The behavior of the magnetic form factor at high momentum transfers is indicated. (J.F.P.)

11570 RATIO OF Λ AND Σ^0 PHOTOPRODUCTION CROSS SECTIONS; HIGH-MASS HYPERON RESONANCES. Greenberg, J. S.; Hughes, V. W.; Lu, D. C.; Minehart, R. C.; Mori, S.; Rothberg, J. E.; Tyson, J. (Yale Univ., New Haven). Contract AT(30-1)-2726-511).

The ratio of Λ to Σ^0 photoproduction cross sections was measured to be 1.25 ± 0.15. The measurement was carried out at center-of-mass angles of about 30°; the observed ratio disagrees with with predictions of a quark model. In the study of K^+ photoproduction for photon energies from 4.0 to 6.1 BeV, evidence was obtained for Y^* states at 2360 and 2530 MeV. (auth)

11571 PHOTOPRODUCTION OF π^0 IN THE BACKWARD DIRECTION. Buschhorn, G.; Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg. Univ. Hamburg). Phys. Rev. Lett., 20: 230-2(Jan. 29, 1968).

The photoproduction of neutral pions in the reaction $\gamma + p \rightarrow \pi^0 + p$ was investigated in the backward direction at 0.8 to 5.5 GeV, using a bremsstrahlung beam from the DESY electron synchrotron and a liquid hydrogen target. Details are given of the experimental setup and measurements. The structure observed in the cross section indicated that resonance contributions are at least comparable with nonresonant contributions, with only the $I = 3/2$ resonances appearing to contribute strongly. A shift was observed in the position of the $\Delta(1920)$ and the $\Delta(2420)$ resonances, which is of the order of $\Delta E = 50$ MeV. Assuming that the $\Delta(2420)$ dominates the backward cross section around 2.5 GeV, a Breit-Wigner fit to the cross section implies that the radiative width $\Gamma_\gamma(2420)$ is of the order of 100 keV. (auth)

11572 EXPERIMENTAL TESTS OF THE VECTOR-DOMINANCE MODEL. Asbury, J. G.; Becker, U.; Bertram, William K.; Binkley, M.; Coleman, E.; Jordan, C. L.; Rohde, M.; Smith, A. J. S.; Ting, Samuel C. C. (Deutsches Elektronen-Synchrotron, Hamburg. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 20: 227-30(Jan. 29, 1968).

Results are presented of the following experimental studies designed to test the validity of the vector-dominance model of electromagnetic interactions of hadrons: (1) measurement of the spectrum of $\rho \rightarrow \pi^+\pi^-$ in the region of high $\pi^+\pi^-$ invariant mass, $930 < m < 1130$ MeV/c^2; and (2) measurement of the forward photoproduction cross section of ρ^0 on carbon, copper, and lead, and the determination of the ρ^0-photon coupling constant from measurement of the branching ratio $\Gamma(\rho \rightarrow e^+e^-)/\Gamma(\rho \rightarrow \pi^+\pi^-)$. The results confirmed the validity of the vector dominance model. (L.B.S.)

11573 SEARCH FOR AN ELECTRON–PROTON CHARGE INEQUALITY BY CHARGE MEASUREMENTS ON AN ISOLATED MACROSCOPIC BODY. Stover, R. W.; Moran, T. I.; Trischka, J. W. (Syracuse Univ., N. Y.). Phys. Rev., 164: 1599-1609 (Dec. 25, 1967).

A new method is reported for testing the electrical neutrality of matter containing an equal number of protons and electrons. A small iron spheroid was magnetically suspended in a uniform, horizontal electric field in such a manner that it was possible to measure electric deflecting forces small enough to detect 0.03 proton charge on the spheroid. An upper limit to the charge difference between the proton and electron, defined by $f = 1 +$ (electron charge)/(proton charge), was found to be $|f| \leq 0.8 \times 10^{-19}$. It was necessary to assume: (neutron charge) = (electron charge) + (proton charge). Values of f in the range $0.8 \times 10^{-19} < |f| < 2.8 \times 10^{-19}$ were excluded, and the probability that $|f| > 0.8 \times 10^{-19}$ is not greater than 0.2. A by-product of the measurements was the finding that the iron spheroids contained less than 1 quark in 2.5×10^{18} nucleons. The measurements also permitted an estimate that the absolute electric charge on 2-eV photons is less than 10^{-16} proton charge. (auth)

11574 BACKWARD PHOTOPRODUCTION OF π^0 IN THE REGION OF THE P_{33} PION–NUCLEON RESONANCE. Croissiaux, M. (Laboratoire de l'Accelerateur Lineaire, Orsay, France. Institut de Recherches Nucleaires, Strasbourg); Dally, E. B.;

Morand, R.; Pahin, J. P.; Schmidt, W. Phys. Rev., 164: 1623-34(Dec. 25, 1967).

The π^0 photoproduction cross section was measured at 180° for photon energies from 220 to 380 MeV, in steps of 20 MeV, by detecting the recoil proton at 0°. The statistical accuracy of the measurements varies between 3 and 7%, depending on the energy. Absolute cross sections were deduced from a comparison of the measurements with electron-proton scattering. The experimental data are compared with theoretical results calculated from fixed-momentum-transfer dispersion relations. Special attention is paid to the prediction of the multipoles at the first resonance, namely, $E_{1+}^{3/2}$, $M_{1+}^{3/2}$, and $E_{0+}^{\pi^0}$ to obtain agreement with experiment. (auth)

11575 IONIZATION LOSS AT RELATIVISTIC VELOCITIES. Nicoletta, C. A.; McNulty, P. J.; Jain, P. L. (State Univ. of New York, Buffalo). Phys. Rev., 164: 1693-8(Dec. 25, 1967).

The variation of grain density in the tracks of 5-, 8-, 12-, and 24-GeV/c protons incident at angles of 75°, 60°, 50°, and 40°, respectively, and of 5-GeV/c pions incident at an angle of 75° to the edge of the plate was investigated as a function of velocity in the same Ilford G-5 pellicle. About 80,000 blobs were counted for each beam. The ratio of grain densities at 5-GeV/c pion to proton is ~1.114 ± 0.01. The results are in agreement with the Sternheimer theory using an ionization potential for AgBr of 434 eV and a cutoff energy T_0 of 2-5 keV, which is in contradiction with the result due to Jongejans (who uses the cutoff energy T_0 = 100 keV), but in agreement with Shapiro's result (T_0 between 2 and 5 keV) and with Barkas's result (with 0–10% correction due to secondary ionization). The data are also consistent with the slow rate of rise in the g* value as a function of velocity which is predicted by the theory. (auth)

11576 A STUDY OF THE LIMITS OF THE VERIFICATION OF QUANTUM ELECTRODYNAMICS BY THE MONTE-CARLO METHOD AND COLLISIONS OF ELECTRON AND POSITRON BEAMS. Amaldi, U. Jr.; Biancastelli, R.; Stein, P. (Istituto Superiore di Sanita, Rome). pp VIIa.6.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26-30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

Experiments were designed to verify the validity of quantum electrodynamics and the hypothesis according to which a muon is nothing but a heavy electron. The three processes to be used in the experiment are $e^+ + e^- \rightarrow e^+ + e^-$, $e^+ + e^- \rightarrow \gamma + \gamma$, and $e^+ + e^- \rightarrow \mu^+ + \mu^-$. The data to be gained from each experiment and the method of comparison between the three experiments are described. (J.S.R.)

11577 PROTON COMPTON EFFECT FOR 300 MeV PHOTONS. Gray, Edward Ray. Urbana, Ill., Univ. of Illinois, 1967. 114p.

Thesis.

Cross section measurements of the elastic scattering of photons by protons were taken at the betatron using a spark chamber technique. The betatron was run at 335 MeV using the newly installed radio frequency cavity. This allowed measurements to be taken at the maximum of the first pion-nucleon resonance. The bremsstrahlung beam was scattered from a liquid hydrogen target, and the scattered photons were converted and detected in a series of lead plates, spark chambers, and scintillation counters. These counters provided electronic triggering information, and the position of the showers produced by the scattered photons was observed in the spark chambers and was used to determine the direction of the scattered photon relative to the photon beam. A spark chamber telescope, which consisted of two aluminum foil spark chambers, a bending magnet, two aluminum foil spark chambers, and two scintillation counters, was used to detect the recoil protons. Again the counters provided trigger information and were required to be in coincidence with the photon detection counters before the spark chambers were triggered. Spark chambers in the proton telescope gave the direction of the proton recoil and the angle of deflection in the bending magnet. This deflection in the magnet was used to calculate the momentum of the proton, and with the direction of the recoil proton, the proton momentum was used to calculate the expected direction of an elastically scattered photon. A comparison of the expected direction of the photon from an elastic event to the observed direction of the scattered photon allowed a statistical separation of the elastic from the inelastic events to be made. The inelastic events corresponded to pi zero photoproduction and represented about 90 percent of the events observed. After being divided into discrete photon energy bins, the number of elastic events observed were used to calculate the average Compton cross section for that bin. The number of inelastic events gave a measured value for the pi zero photoproduction cross sections, and these cross sections were compared to existing measurements and theory. Since this process had been well established by other measurements, the comparison of the values of the pi zero cross sections measured in this experiment to earlier values established the correctness of the measurement procedure of this experiment. The Compton cross sections in micro barns per steradian obtained at the 90° CMS angle were .145 ± .016 for an energy bin of 285 to 335 MeV and .155 ± .031 for a bin of 260 to 285 MeV. For the 135° an angle the values were .213 ± .018 for a 285 to 335 MeV bin, .152 ± .016 for a 235 to 285 MeV bin, and .0442 ± .0076 for a 185 to 235 MeV bin. The pi zero photoproduction cross sections obtained at the 90° CMS angle were 26.4 ± 1.6 for 285 to 335 MeV, 18.5 ± .4 for 260 to 285 MeV, and 9.60 ± .5 for 235 to 260 MeV. For the 135° angle the values are 18.7 ± .3 for 285 to 335 MeV, 10.1 ± .2 for 235 to 285 MeV, and 2.98 ± .13 for 185 to 235 MeV. At the 135° angle the two lower energy Compton cross sections measured were in agreement with previously measured values taken by an Illinois group, and the high energy cross section measurement provided new data at the 135° angle essentially in agreement with theory. The 90° values were in agreement with previous Illinois measurements on the low energy side and with Cornell measurements on the high energy side at the middle of the first pion-nucleon resonance. Both the present 90° measurement at about 310 MeV and the Cornell measurement with which it agrees are in disagreement with existing theories and remain unexplainably low. (Disser. Abstr.)

Weak

Refer also to abstracts 11827 and 12002.

11578 STUDIES OF $K_2^0 \rightarrow \pi^+\pi^-$ DECAY AND INTERFERENCE. Fitch, V. L.; Roth, R. F.; Russ, J.; Vernon, W. (Princeton Univ., N. J.). Contract N0014-67-A-0151-0001. Phys. Rev., 164: 1711-21(Dec. 25, 1967).

A detailed study of the CP-violating decay $K_2^0 \rightarrow \pi^+ + \pi^-$ in an experiment performed at the Brookhaven AGS is described. In a search for an energy dependence in the branching ratio, BR = rate ($K_2^0 \rightarrow \pi^+ + \pi^-$)/rate ($K_2^0 \rightarrow$ all charged modes), it is found between 0.95 and 2.45 GeV that if BR $\propto E_n$ then n = 0.03 ± 0.33. Assuming n = 0, then BR = (1.97 ± 0.16) × 10^{-3}, yielding $|\eta_0|$ = (1.91 ± 0.09) × 10^{-3}. In an interference experiment at a mean momentum of 1.55 GeV/c, cos α = 1.00 ± 0.21 was observed, where α is the phase angle between the $K_2^0 \rightarrow \pi^+ + \pi^-$ decay amplitude and the $\pi^+\pi^-$ amplitude from coherent regeneration in uniformly distributed Be. A search for neutral currents yields a limit on the branching ratio of $K_2^0 \rightarrow \mu^+ + \mu^-$ of 3.5 × 10^{-5} and $K_2^0 \rightarrow \mu^+ + e^-$ of 8 × 10^{-6} (both 90% confidence levels). The mass of the K_1^0 was measured to be 497.44 ± 0.50 MeV. (auth)

11579 SIGN OF THE $K_L^0 - K_S^0$ MASS DIFFERENCE. Fischbein, William L. Madison, Wis., Univ. of Wisconsin, 1967. 92p.

Thesis.

An experiment to measure the sign of the $K_L^0 - K_S^0$ mass difference was performed using the method of neutral kaon-proton scattering. The intensity of $K_S^0 \rightarrow \pi^+\pi^-$ decays measured after scattering, as a function of the proper time between the production and interaction of the K^0, is sensitive to this sign. The K^0 were obtained in K^-p charge exchange in the LRL 25'' bubble chamber filled successively with hydrogen and deuterium with K^- beam momenta ranging from 825 to 1115 MeV/c. Approximately 400,000 pictures were searched for events of this type, yielding a final acceptable sample of 17 such events, 10 in hydrogen and 7 in deuterium. The method of maximum likelihood was then employed to determine which sign is favored and by what betting odds. The scattering amplitudes used in the expression for the K_S intensity were obtained from overall fits to available data on K^+p, K^+n, K^-p and K^-n scattering parameters. The Fermi-Yang ambiguity in the S = +1, I = 0 system remains unresolved, although present information favors the Yang solution. Using a fixed value of the magnitude of the mass difference equal to 0.60 and the Yang solution, we obtained betting odds of 2.4 to one favoring $m_{K_L^0} > m_{K_S^0}$. (Diss. Abstr.)

11580 AN EXPERIMENTAL STUDY OF THE DECAY $K^+ \rightarrow \pi^0 + e^+ + \nu$. Sperling, S. Martin. Madison, Wis., Univ. of Wisconsin, 1967. 47p.

Thesis.

The kinematic properties of the weak interaction associated with the decay $K^+ \rightarrow \pi^0 + e^+ + \nu$ were studied by observing kaons stopping in a freon bubble chamber. From 600,000 stopping K, a sample of 221 events was obtained. An analysis of the distribution of π opening angles—that is, of the angles formed by gamma pairs from the decaying π's—leads to the conclusion that the interaction

is predominantly vector, with an energy variation d(amplitude)/d(invariant mass of di-lepton)^2 = .01 + .04 m_π^2. (Diss. Abstr.)

Strong (Baryon-Induced)

Refer also to abstract 11902.

11581 (UCRL-17943) PRODUCTION OF K MESONS IN THREE-BODY STATES IN PROTON–PROTON INTERACTIONS AT 6 GeV/c. Mandelkern, Mark Alan (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 79p. Dep. CFSTI.

Thesis.

An analysis is presented of data from an exposure of the LRL 72" liquid hydrogen bubble chamber to a 6 BeV/c proton beam. Processing of 9700 events, containing at least one observed neutral or charged decay has yielded 1748 examples of the reaction proton + proton → hyperon + K meson + nucleon. Production cross sections for these three body reactions are $\sigma(\Lambda K^+p)$ = 54^{+8}_{-8} μb; $\sigma(\Sigma^0K^+p)$ = 17^{+4}_{-2} μb; $\sigma(\Sigma^+K^0p)$ = 26 ± 4 μb; $\sigma(\Sigma^+K^+n)$ = 57 ± 7 μb. Strong N* production is observed in all channels. In particular one or more T = ½ resonant states with mass near 1700 MeV/c^2, decaying into ΛK^+, and a T = 3/2 resonance with mass 1920 MeV/c^2, decaying into ΣK, are produced. The final states ΛpK^+ and Σ^+K^+n are studied in detail. In both cases the data are consistent with a single pion exchange mechanism modified by a form factor and inconsistent with kaon exchange. The remaining two reactions are found qualitatively to have these properties as well. No evidence is found for a dibaryon state in either the Λ-proton or Σ-nucleon system. Cross section relations among three-body final states of pp reactions implied by exact SU_3 symmetry are tested and found to be inconsistent with the data. (auth)

11582 INVESTIGATION OF NUCLEONS EMITTED FROM ^{9}Be AND ^{4}He DURING BOMBARDMENT WITH 660-MeV PROTONS. Kon'shin, V. A.; Matusevich, E. S.; Regushevskii, V. I.; Selyutin, V. P.; Tambovtsev, D. I. Yadern. Fiz., 6: 877-8 (Oct. 1967). (In Russian).

Angular distributions and number of cascade nucleons (E > 60 MeV) were measured at a target thickness of 4.76 g/cm^2 for ^{9}Be and 1.5 g/cm^2 for ^{4}He. Threshold detectors of ^{238}U($E_{thres.}$ ≈ 1 MeV), Bi($E_{thres.}$ ≈ 60 MeV) and Re($E_{thres.}$ ≈ 140 MeV) were arranged at a distance of 30 cm from the target center in order to determine the number and distribution of nucleons emitted from the ^{9}Be and ^{4}He targets. The number of cascade nucleons having an energy E > 60 MeV, which are emitted per single inelastic interaction, was found to be 2.9 ± 0.4 for ^{9}Be and 3.2 ± 1.0 for ^{4}He. These results indicate an increase in number of cascade nucleons per single inelastic interaction with decreasing atomic number. (TTT)

11583 SCATTERING OF PROTONS BY DEUTERIUM FROM 1.0 TO 2.0 GeV. Coleman, E.; Heinz, R. M.; Overseth, O. E.; Pellett, D. E. (Univ. of Michigan, Ann Arbor). Contract Nonr-1224(23). Phys. Rev., 164: 1655-61(Dec. 25, 1967).

The differential cross sections for proton–deuteron elastic scattering at high momentum transfers were measured at incident proton kinetic energies from 1 to 2 BeV in a counter experiment. The differential cross sections for backward elastic scattering at incident kinetic energies of 1.0, 1.3, and 1.5 BeV were measured for values of the cosine of the center-of-mass proton scattering angle (cos θ*) from −0.5 to −0.9, which corresponds to values of the four-momentum transfer squared (−t) from 2.6 to 5.0 (BeV/c)^2. A backward peak is observed, and the cross section decreases rapidly with increasing energy. At 2.0 BeV, the forward elastic differential cross section was measured for −t from 0.44 to 1.54 (BeV/c)^2, or cos θ* from 0.875 to 0.565. A shoulderlike departure from the forward diffraction peak is observed. (auth)

11584 MEASUREMENTS OF THE POLARIZATION PARAMETERS P AND C_{nn} IN pp ELASTIC SCATTERING BETWEEN 500 AND 1200 MeV. Cozzika, G. (Centre d'Etudes Nucleaires de Saclay, France); Ducros, Y.; de Lesquen, A.; Movchet, J.; Raoul, J. C.; van Rossum, L.; Deregel, J.; Fontaine, J. M. Phys. Rev., 164: 1672-9(Dec. 25, 1967).

The polarization parameter P and the spin correlation parameter C_{nn} in proton–proton elastic scattering were measured in an experiment with a polarized-proton target in the beam extracted from the synchrotron "Saturne." The angular distribution of P was measured at 7 energies between 0.5 and 1.2 GeV. The value of P shows a maximum of +0.6 at about 700 MeV for a scattering angle of 45° in the center-of-mass system. At 1.2 GeV the value of P is consistent with 0 for scattering angles ≥70° (momentum transfers $-t \geq 0.8$ (GeV/c)^2]. The spin correlation coefficient C_{nn} was measured at three energies, 0.735, 0.978, and 1.19 GeV, by scattering a polarized-proton beam on the polarized target. The value of C_{nn} at 90° c.m. decreases from 0.7 to 0.4 as the energy increases from 0.735 to 1.19 GeV. (auth)

11585 SEARCH FOR EXCITED BARYONS IN PERIPHERAL NUCLEUS–NUCLEUS INTERACTIONS IN NUCLEAR EMULSION. Jurak, A. (Inst. for Nuclear Research, Krakow). Acta Phys. Pol., 32: 927-33(Dec. 1967).

From a sample of peripheral nucleus-nucleus collisions a group of events has been selected which can be regarded with a high degree of probability as a sub-sample of interactors of a pair of quasi-free nucleons, constituents of the colliding nuclei. An analysis of angular distributions of these events has shown a significant difference between the interactions with a small number of charged particles produced ($1 \leq n_m \leq 3$) and those with a higher one ($4 \leq n_m \leq 12$). The angular distributions of the former are not inconsistent with the assumption that meson production in these events occurs through an intermediate isobaric states with masses of about 2.5 GeV. (auth)

11586 NUCLEON ISOBAR PRODUCTION IN PROTON–PROTON COLLISIONS FROM 3 TO 7 GeV/c. Ankenbrandt, Charles Martin. Berkeley, Calif., Univ. of California, 1967. 132p.

Thesis.

A systematic study of the reactions pp → pp and pp → pN* in the angular range from $\theta_{lab} = 10°$ to $\theta_{cm} = 90°$ at 3, 4, 5, 6, and 7 GeV/c is reported. A "missing mass" spectrometer detected protons resulting from interactions of the Bevatron external proton beam in a liquid hydrogen target. The spectrometer consisted of a series of bending and focusing magnets and a scintillator hodoscope. Peaks in the missing mass spectra occur at average N* masses of 1240 ± 6 MeV, 1508 ± 2 MeV, and 1683 ± 3 MeV with average full widths of 102 ± 4 MeV, 92 ± 3 MeV, and 110 ± 4 MeV respectively. In the missing mass region below 2400 MeV no other significant enhancements are found. Comparison of the N* production cross sections $d\sigma/dt$ near $\theta_{cm} = 90°$ with the predictions of the statistical model indicates partial success of the model. The differential cross sections at fixed energy manifest exponential dependence on v = [−tu/(t + u)], a symmetric function of the Mandelstam variables t and u, which reduces to the squared transverse momentum transfer for elastic scattering. The slopes of these exponentials vary systematically with energy in a way that depends on the particular reaction under consideration; but all these slopes tend toward the same value [v_0 = 0.4 GeV^2] at the upper limit of our energy range. (Diss. Abstr.)

11587 ISOBAR PRODUCTION MECHANISMS IN PROTON–PROTON COLLISIONS AT 5 GeV/c. Colleraine, Anthony Patrick. Princeton, N. J., Princeton Univ., 1967. 160p.

Thesis.

Approximately 7500 4 prong proton-proton collisions at 5 GeV/c were studied using the hydrogen bubble chamber. The three principal reactions with their cross sections were determined to be: (a) p + p → p + p $\pi^+ + \pi^-$ (2.96 ± 0.12) mb. (b) p + p → p + p + $\pi^+ + \pi^- + \pi^0$ (1.76 ± 0.07) mb. (c) p + p → p + n + $\pi^+ + \pi^+ + \pi^-$ (2.19 ± 0.09) mb. In each reaction both single and double N* production occurs and the decay angular distributions and density matrix elements were calculated whenever possible. These parameters indicate that pseudoscalar exchange appears to be dominant at low momentum transfers and that for higher values of momentum transfer absorptive effects become important. The formation of the eta and omega meson resonances are observed in reaction (b) but in none of the reactions is any significant rho meson production found to occur. (Disser. Abstr.)

Strong (Meson-Induced)

Refer also to abstract 10602.

11588 EVIDENCE FOR THE I = ½N*(1400) RESONANCE PRODUCTION IN π^+p INTERACTIONS AT 6 GeV/c. Bell, Robert B. (Brookhaven National Lab.; Upton, N. Y.); Crennell, David J.; Hough, Paul V. C.; (and others). Phys. Rev. Lett., 20: 164-7(Jan. 22, 1968). (BNL-12017).

The observation of well-defined π^+n and π^-p enhancements centered at 1.42 GeV with a width of the order of 100 MeV is reported from a study of the interactions π^+p → $\pi^+\pi^+$n and π^-p → $\pi^0\pi^-$p at 6 GeV/c in the BNL 80-in. hydrogen bubble chamber. The isospin of the πN enhancement was determined to be ½. (L.B.S.)

11589 GENERALIZED DECK EFFECT AND $\overline{K}^{*0}$(1300) PRODUCTION IN K^- + p → K^- + π^+ + π^- + p AT 5.5 GeV/c. Park, J. C. (Univ. of Illinois, Urbana); Kim, S.; Chandler, G.; Ascoli, G.; Goldwasser, E. L.; Wangler, T. P. Contract AT(11-1)-1195. Phys. Rev. Lett., 20: 171-4(Jan. 22, 1968). (COO-1195-101).

A comparison is made of the generalized Deck effect with the data from a K^-p experiment at 5.5 GeV/c in the 30-in. MURA hydrogen bubble chamber. In addition to the usual Deck model, which

involves the dissociation of K^- into $\bar{K}^{*0}$ and π^- with (virtual) elastic scattering of the π^- with the target proton, two other processes are considered. Parameters and results for several calculations of the model are tabulated. Some properties of events in the $\bar{K}^{**}$ (1300) region, suggesting the production of a $1 + \bar{K}^*\pi$ system via vacuon exchange are summarized. (L.B.S.)

11590 π^-p TWO-PRONG INTERACTIONS AT 4.16 GeV/c. Eisner, R. L.; Johnson, P. R.; Klein, P. R.; Peters, R. E.; Sahni, R. J.; Yen, W. L.; Tautfest, G. W. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 164: 1699-1710(Dec. 25, 1967).

An analysis of π^-p two-prong interactions at 4.16 GeV/c is presented. The total two-prong cross section is 19.11 ± 0.40 mb, based on 33,672 events. The elastic-scattering differential cross section shows an exponential behavior, K exp $(-A\Delta^2)$. With A = 7.36 ± 0.14 GeV^{-2}, the "absorption parameters" are derived as $C_+ = 0.846 \pm 0.017$ and $\gamma_+ = 0.040 \pm 0.001$. The final-state $\pi^-\pi^0p$ exhibits a strong ρ^-, and the $\pi^-\pi^+n$ a strong ρ^0 and f^0. The partial cross sections for the dominant resonant channels $p\rho^-$, $\pi^-\Delta^+(1236)$ ($\rightarrow p\pi^0$), ρ^0n, and f^0n are 0.59 ± 0.03, 0.17 ± 0.01, 1.15 ± 0.05, and 0.53 ± 0.06 mb, respectively. The ρ^- production and decay angular distributions do not agree with the predictions of the absorption-modified one-pion-exchange model. However, an inclusion of the contribution from ω exchange adequately accounts for the discrepancy. The ρ^0 asymmetry is interpreted as a result of an interference of the resonant P wave and isospin-zero S wave, and the corresponding spin-density matrix elements are obtained. In the final state π^-p + neutrals, a clear peak for the η meson and some evidence for the ω meson are seen. (auth)

11591 π^+p INTERACTIONS AT 900 MeV. Metzger, W. J.; Forman, B.; Melissinos, A. C.; Yamanouchi, T. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 164: 1680-92(Dec. 25, 1967). (UR-875-186).

The results are reported of the investigation of 18,500 frames of π^+p interactions in the Brookhaven 20-in. bubble chamber at an incident energy of 900 MeV. It is found that single-pion production proceeds almost entirely through formation of the N^*_{33} isobar. The production mechanism of the N^*_{33} is analyzed in terms of its spin density matrix. Comparison is made with Stodolsky and Sakurai's ρ-exchange model and with the absorptive peripheral model. (auth)

11592 MEASUREMENT OF π^-p ELASTIC SCATTERING AT 180°. Kormanyos, S. W. (Univ. of Michigan, Ann Arbor); Krisch, A. D.; O'Fallon, J. R.; Ruddick, K.; Ratner, L. G. Phys. Rev., 164: 1661-71(Dec. 25, 1967).

The differential cross section for π^-p elastic scattering was measured at 180° in steps of 0.10 GeV/c or less in the region P_0 = 1.6 to 5.3 GeV/c. Elastic scattering events from protons in a liquid H_2 target were detected with a double spectrometer consisting of magnets and scintillation counters in coincidence. The incident π^- beam was counted by scintillation counters. The cross section was found to have considerable structure. This may be interpreted as interference between the resonant amplitudes and the nonresonant or background amplitude. Very strong destructive interference occurs around P_0 = 2.15 GeV/c, where the cross section drops almost two orders of magnitude in passing through the N*(2190). Another interesting feature of the data is a large narrow peak in the cross section at P_0 = 5.12 GeV/c, providing firm evidence for the existence of a nucleon resonance with a mass of 3245 ± 10 MeV. This N*(3245) has a full width of less than 35 MeV, which is about 1% of its mass. From this experiment the parity and the quantity $\chi(J + \frac{1}{2})$ were determined for each N* resonance, where χ is the elasticity and J is the spin of the resonance. (auth)

11593 FAILURE TO OBSERVE A MESON DECAYING INTO $\pi^+\pi^0$ IN THE REACTION $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$ WITH 968-MeV/c INCIDENT π^+. Mockett, P. M.; Mannelli, I.; Wahlig, M. A.; Frisch, D. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 164: 1621-3(Dec. 25, 1967). (MIT-2098-325; MIT-2098-342).

In a search for a meson decaying into $\pi^+\pi^0$, the reaction $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$ was studied at an incident pion momentum near 1 BeV/c. The dipion mass spectrum of almost 7000 events shows no statistically significant bumps, giving an upper limit of approximately 0.1 mb (99% confidence) for a meson with a width narrower than our dipion mass resolution (about ±10 MeV). (auth)

11594 THE REACTION $pp \rightarrow pn\pi^+$ AT 10 GeV/c AND THE OPE MODEL. Dehne, H.-C. (Institute fuer Experimentalphysik, Hamburg); Diaz, J.; Stroemer, K.; Schmitt, A.; Swanson, W. P.; Borecka, I.; Knies, G.; Wold, G. Nuovo Cim. (10), 53A: 232-41(Jan. 1, 1968).

The reaction $pp \rightarrow pn\pi^+$ and isobar production in $pp \rightarrow N^{*2+}(1236)n$ were studied at 10 GeV/c. The data are compared with one-pion exchange models with form factors and with absorption corrections. (auth)

11595 A SEARCH FOR THE ϵ^0-MESON. Gezelter, J.; Lichtman, S.; Loeffler, F. J.; Miller, R. J.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Nuovo Cim. (10), 53A: 213-20(Jan. 1, 1968). (COO-1428-33).

A search was made for the neutral decay mode of the proposed isoscalar, scalar meson (ϵ^0) by analysis of the missing-mass spectrum of the reaction $\pi^+ + d \rightarrow p_{sp} + p +$ neutrals at 2.7 GeV/c. After subtraction of a well-established number (determined from analysis of the pp $\pi^+\pi^-\pi^0$ final state) of neutral decays of the ω-meson, an enhancement of ≤45 events above background remains in the mass region in the neighborhood of 800 MeV/c^2. It is argued that these events are probably due to a proton contamination in the beam and that the experiment, therefore, provides no evidence for the existence of the ϵ^0-meson. (auth)

11596 MEASUREMENT OF THE Σ^- POLARIZATION IN THE PROCESS $\pi^- + p \rightarrow \Sigma^- + K^+$. Weldon, David Michael. Berkeley, Calif., Univ. of California, 1967. 52p.

Thesis.

The average polarization of the Σ^- produced in the reaction $\pi^- + p \rightarrow \Sigma^- + K^+$ was measured between center-of-mass angles 134° and 166° for an incident π^- momentum of 1145 MeV/c. A polarized proton target was used and the Σ^- polarization was found by measuring the difference in the production-rate of K^+ mesons for protons polarized along the production-plane normal and against it. Spark chambers were used to record the π^- and K^+ trajectories, and the π^- momentum was obtained from a magnetic spectrometer while the K^+ momentum was obtained from a range telescope. Each event was kinematically reconstructed in a one constraint fit to help eliminate events produced from protons bound in heavy nuclei of the target. The Σ^- polarization was found to be −0.36 ± 0.46. (Diss. Abstr.)

11597 MULTIPLE PION PRODUCTION IN K^+p COLLISIONS AT 3.5 GeV/c. Goshaw, Alfred Thomas. Madison, Wis., Univ. of Wisconsin, 1966. 212p.

Thesis.

An analysis is made of K^+-proton interactions in which three or four pions are produced. The experiment was conducted in the Brookhaven 80 inch bubble chamber using an incident beam of 3.5 BeV/c K^+ mesons. Events of the type $K^+ + p \rightarrow K^0 + p +$ (3 or 4π's)$^+$ were selected from the four prong plus V° topology. A search is made in these reactions for the production of excited states of the K meson which decay with the emission of one or more pions. A review of the experimental evidence for K meson resonant states is presented. The kappa (725) and $K^*(892)$ are discussed in some detail. Evidence is presented for a K^* resonance of mass 1305 MeV. Upper limits are measured for the Kω and Kη decays of the $K^*(1405)$. A $K^{2+}(892)\pi^+$ enhancement observed in this data at 1180 MeV can be explained by means of a final state interaction (triangle diagram). In addition to a study of K excited states, the properties of the ω and η mesons are studied. The observed decay properties of the ω do not agree with the predictions of the simplest $J^P = 1^-$ matrix element. An upper limit on the η width is measured. (Diss. Abstr.)

11598 CHARGE EXCHANGE SCATTERING OF K^+ MESONS ON ^{9}Be AT 0.970 GeV/C. Gezelter, Joseph. Princeton, N. J., Princeton Univ., 1967. 137p.

Thesis.

The angular distribution of K^0 mesons from the reaction $K^+ + n \rightarrow K^0 + p$ was measured using a .970 GeV/c K^+ beam incident on a thin plate spark chamber which contained beryllium targets. The cms angular distribution was obtained after corrections were made for N^* production and the geometry of the spark chamber. The method of least squares was used, and six sets of real, I = 0, S and P wave phase shifts were found which were the locations of local minima. I = 1, complex, S and P wave phase shifts and the $K^+ - n$ total cross section given by Cook in UCRL-10130 were used in the phase shift analysis. The six sets of solutions can be broken up into 3 groups of 2 sets each with the sets in each group approximately related by the Fermi-Yang ambiguity. One of these groups is very similar to the two Fermi-Yang solutions which workers at lower energies have favored. Only one of these sets predicts a value for the $K^+ - n$ total charge exchange cross section which is close to the apparent plateau value found at lower energies. None of the other sets predicts a reasonable value for the $K^+ - n$ charge exchange cross section. (Diss. Abstr.)

11599 ELASTIC SCATTERING OF K^+ MESONS BY ^{9}Be AT 950 MeV/c. Murphy, Frederick V. Jr. Princeton, N. J., Princeton Univ., 1967. 114p.

Thesis.

A velocity-selecting Čerenkov counter in a 950 MeV/c 13° beam at the accelerator identified K^+ mesons, which then interacted in ^{9}Be targets in a thin plate spark chamber. Photographs of the scattering were automatically scanned and digitized by a flying-spot cathode ray tube controlled by a PDP-1 computer. The spark

coordinates were used to identify and reconstruct 4,000 nuclear elastic scatterings. The differential cross section was fit by a nuclear optical model, assuming a modified Gaussian shape, with a complex repulsive potential U = (+5 ± 5) MeV −i(28 ± 3) MeV. The volume integral of this potential agrees well with a prediction from the K^+-nucleon forward scattering amplitudes computed from the T = 1 s-wave and p-wave phase shifts known at this momentum and from the T = 0 s-wave and p-wave phase shifts extrapolated from measurements up to 812 MeV/c. This suggests that the T = 0 and T = 1 S = +1 K^+-nucleon scattering is still dominated by s-waves and p-waves at 950 MeV/c. (Disser. Abstr.)

11600 MEASUREMENT OF THE POLARIZATION PARAMETER IN THE ELASTIC SCATTERING OF NEGATIVE PIONS BY PROTONS FROM 600 TO 3300 MeV/c. Hansroul, Michel. Berkeley, Calif., Univ. of California, 1967. 72p.

Thesis.

The polarization parameter in π^-p elastic scattering was measured at eleven incident-pion momenta ranging from 600 to 3300 MeV/c. The negative pion beam was focused on a polarized proton target and the scattered pion and recoil proton were detected in coincidence by counter hodoscopes. The polarization parameter was obtained from a measurement of the difference in counting rates for the target protons' spins parallel and anti-parallel to the normal to the scattering plane. An on-line PDP-5 computer was used in the data encoding and transferred the information onto magnetic tape for later computer analysis. The results serve to fill in some gaps in previous experiments. An attempt to fit the new data and previously available data by means of a phase-shift analysis for energies below 1050 MeV was successful in finding good fits to the data but was unsuccessful in that no unique solution was demonstrated. (Disser. Abstr.)

11601 PROPERTIES OF SELECTED FINAL STATES IN THE REACTION $K^- + p \rightarrow$ FOUR-PRONG TOPOLOGIES AT 3.8 GeV/C. Hendricks, Tareah John. San Diego, Calif., Univ. of California, 1967. 134p.

Thesis.

The properties of the $K^*(1410)$ and $\varphi(1020)$ mesons are studied and the production cross sections of various final states are determined. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

11602 (PadovaU-LA-1) CURRENT ALGEBRA SUM RULES AND ASYMPTOTIC BEHAVIOUR. Sartori, G.; Tonin, M. (Padua Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Padua (Italy)). [1967]. 16p. Dep.

A new method is proposed to derive covariant sum rules from current algebra. This method is used in discussing the convergence properties of the sum rules and the limiting procedure required to obtain them. (auth)

11603 GRAPHICAL METHODS FOR THE EXECUTION OF THE THE γ OR σ-ALGEBRA IN SPINOR THEORIES. Duerr, H. P.; Wagner, F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim. (10), 53A: 255-85(Jan. 1, 1968).

The angular momentum decomposition in theories involving fields or many particles with nonzero spin, in particular spinor fields or spin-$\frac{1}{2}$ particles, soon becomes extremely intricate, since it involves the evaluation of higher products of γ- or σ-matrices contracted with tensors of high rank constructed from various linear 4-momenta. It is shown that such expressions can be simply represented by graphs which after angular integration go over into graphs corresponding to Wigner 3nj-symbols. For the evaluation of these Wigner 3nj-symbols in terms of products of 6j-symbols graphical reduction formulas are given which not only serve as an intuitive aid in the classification but allow one to determine the exact result including the phase factors. (auth)

11604 HIGH-ENERGY COLLISIONS OF NONRELATIVISTIC COMPOSITE SYSTEMS. Chylinski, Z. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol., 32: 839-53(Nov. 1967).

The construction of the matrix element is proposed for an elementary particle colliding with a composite nonrelativistic system. This construction is based on the hypothesis of the phase geometry. A short summary of the phase geometry framework, and of some of its most important consequences is provided. (auth)

11605 GENERALIZED FUNCTIONS IN ELEMENTARY PARTICLE PHYSICS AND PASSIVE SYSTEM THEORY: RECENT TRENDS AND PROBLEMS. Guettinger, W. (Univ., Munich). SIAM (Soc. Ind. Appl. Math.) J. Appl. Math., 15: 964-1000(July 1967).

The present state of knowledge concerning the application of generalized functions to problems of passive system theory and elementary particle physics is reviewed. After a survey of the basic concepts of generalized functions, some new developments are outlined. A compact integral representation for singular generalized functions is derived, leading to a generalization of the notion of pseudofunction and of Bochner's formula. An unsubtracted generalized Hilbert transform for increasing functions is discussed and confronted with subtracted dispersion relations obtained from boundary values of analytic functions. Product theories for generalized functions are developed and their connection with generalized Hilbert transforms is established. The local structure of infinite series of derivatives of delta functions is analyzed in terms of analytic functions and a causal high frequency/energy bound in system theory is derived from this. Generalized functions with essential singularities arising from unstable systems are discussed. Linear and nonlinear passive system theories and elementary particle theories are outlined, and the new generalized function techniques are used to analyze various aspects of these theories. (BBB)

11606 HIGH ENERGY PHYSICS PROGRAM: REPORT ON NATIONAL POLICY AND BACKGROUND INFORMATION. Washington, D. C., Joint Committee on Atomic Energy, 1965. 180p. GPO $0.55.

The policy for national action in the field of high energy physics is outlined. A number of other reports and background data are also included. (J.F.P.)

11607 HIGH ENERGY PHYSICS RESEARCH. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION, MARCH 2, 3, 4, AND 5, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 809p. GPO $2.50.

The hearings on high-energy physics include statements in this field by various scientists. Accelerators, detectors, high-energy physics experiments, and federal expenditures for research and development and proposed costs for high-energy physics are discussed. A number of other reports and background data are also included. (J.F.P.)

11608 PARTICLE INTERACTIONS AT HIGH ENERGIES. Preist, T. W.; Vick, L. L. J. (eds.). Scottish Universities' Summer School, 1966. New York, Plenum Press, 1967. 418p. $22.50.

Separate abstracts are prepared for the eight lectures presented on strong, weak, and electromagnetic interactions. (L.B.S.)

For abstracts of individual sections see: 11611, 11645, 11646, 11670, 11695, 11702, 11715, and 11734.

Electromagnetic

Refer also to abstracts 11647 and 11648.

11609 (NP-17221) PHOTOPRODUCTION OF PSEUDOSCALAR MESONS. Rollnik, H. (Bonn Univ. (West Germany). Physikalisches Institut). Mar. 1967. 107p. Dep.

A discussion of the empirical knowledge and its theoretical interpretation for the photoproduction of single pseudoscalar mesons on nucleons is presented. Restriction is made to the production of mesons (π), (K), and (η) in the processes $\gamma + p \rightarrow \pi^+ + n$, $\gamma + p \rightarrow \pi^0 + p$, $\gamma + n \rightarrow \pi^- + p$, $\gamma + p \rightarrow \eta + p$, and $\gamma + p \rightarrow K^+ + \Lambda\ (\Sigma^0)$. A survey of experiments and an elementary outline of the semi-phenomenological treatment of the photo-excitation of isobars are given. Isospin and SU(3) considerations are also given, and the most important conclusions of the quark model are explained. More detailed theoretical attempts for isobar excitation are developed, and an account of the theoretical ideas and their main results which have led to some understanding of single pseudoscalar meson photoproduction is presented. (J.F.P.)

11610 FLUCTUATIONS IN THE THREE-DIMENSIONAL SHOWER CASCADE THEORY. Gedalin, E. V. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 47: 43-7(July 1967). (In Russian).

Fluctuations in the development of three-dimensional cascade showers were studied previously without taking into account the length of particle scattering trajectories (because it was assumed that particle scattering probability differs significantly from zero only at very small angles). An attempt is made to evaluate an arbitrary cascade process with participation of the m type particles considering the stochastic process of cascade development as a Markovian process. (R.V.J.)

11611 SOME FEATURES OF ELECTROMAGNETIC INTERACTIONS. Wilson, Richard (Harvard Univ., Cambridge, Mass.). pp 112-98 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

Experimental and theoretical features of electromagnetic interactions are presented in a manner which is appropriate for experimenters. The following topics are treated: elastic electron scattering, neutron form factors; theory of form factors; colliding beam devices, inelastic electron-proton scattering; two-photon exchange effects; and quantum electrodynamics experiments. 146 references. (L.B.S.)

11612 CALCULATION OF THE n–p MASS DIFFERENCE. Srivastava, Yogendra (Northeastern Univ., Boston). Phys. Rev. Lett., 20: 232-4(Jan. 29, 1968).

Assuming that the Regge asymptotic behavior prevails and using a generalized superconvergence relation, the first-order electromagnetic nucleon mass difference was computed. $M_p - M_n \approx -1.4$ MeV was found and compared with the experimental value −1.3 MeV. (auth)

11613 RELATIVISTIC SCHROEDINGER EQUATION FOR A PARTICLE WITH ARBITRARY SPIN. Ionesco-Pallas, Nicolas J. (Inst. of Atomic Physics, Bucharest). J. Franklin Inst., 284: 243-50(Oct. 1967).

All relativistic theories describing particles with arbitrary spin assume as a starting point the linearity of equations in terms of four-momentum components. This generalization of the Dirac equation presents a double difficulty; i.e., the properties of $\Gamma\mu$ matrices are expressed by more and more intricate relations as far as particles of higher spin are concerned; the number of wave-function components increases markedly under the same conditions. Moreover, the usual analysis stops at spin-1 particles because the various spin-$^3/_2$ theories do not give the same minimum number of components for the wave function. A relativistic extension of the Schrödinger equation for a particle of arbitrary spin, which avoids these difficulties, is proposed. Only the case when the particle evolves in an external field of spin-1 (electromagnetic field) is considered. The relativistic quadratic wave equation valid for an arbitrary spin particle which is derived can be considered a Lorentz-invariant generalization of the Schrödinger-Pauli equation, since only spin S matrices are involved. The system of (2S + 1) recursive differential equations for wave function components is explicitly worked out. A possible extension is advocated to include anomalous magnetic moments, and the possibility of using the new equation in electromagnetic interactions is suggested. (BBB)

11614 INELASTIC ELECTRON SCATTERING FROM PROTONS. Lynch, H. L.; Allaby, J. V.; Ritson, D. M. (Stanford Univ., Calif.). Contract Nonr 225(67). Phys. Rev., 164: 1635-54(Dec. 25, 1967).

A large body of data is presented on inelastic electron scattering at energies up to 1.1 GeV. Only the scattered electrons were detected. Part of the measurements were made at fixed momentum transfer and fixed scattered electron energy over a region of energy loss concentrating on the first pion-nucleon resonance. The other measurements were made at fixed momentum transfer and fixed equivalent photon energy in the region of the first resonance, varying the scattered electron energy. The transverse part σ_t is found to be dominant, but the longitudinal part σ_l is nonzero at the first resonance. The results suggest that the proton and first resonance share a common magnetic form factor. (auth)

11615 INELASTIC MODEL OF THE n–p MASS DIFFERENCE: CALCULATIONS. Gaisser, T. K.; Fried, H. M. (Brown Univ., Providence). Contract AT(30-1)-2262. Phys. Rev., 164: 1722-5(Dec. 25, 1967). (NYO-2262TA-158).

A detailed calculation of the n–p mass difference is carried out based on a field-theoretic "rainbow graph" model. The model incorporates a feedback mechanism which could account for the observed sign of the nucleon electromagnetic mass splitting. The effect on the model of a dressed pseudoscalar-pion–nucleon vertex function is briefly discussed. (auth)

11616 SOME DIFFICULTIES IN THE FIELD-THEORETIC APPROACH TO THE PROTON–NEUTRON MASS DIFFERENCE. Rockmore, Ronald (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., 164: 1929-31(Dec. 25, 1967). (SLAC-PUB-331).

Some consequences of a manifest lack of gauge invariance in the usual field-theoretic approach to the calculation of the proton–neutron mass difference are pointed out. In particular, it is shown that the assumption Z = 0 (where Z is the strong wave-function renormalization constant) is inessential to this problem of gauge dependence. A practical calculation of $\delta M = M_p - M_n$, assuming Z = 0 and relying on Drell and Pagels's method of low-mass dominance, is carried out. The cutoff for this calculation, $\lambda^2 = 3.6$ for $(g^2/4\pi) = 15$, is determined by requiring that Z = 0 be satisfied to $O(g^2)$. If we accept the possibility that the prescription adopted by Bassetto and Paccanoni for extracting a gauge-independent result has some basis, then we find, on including the effects of the anomalous nucleon moments, that $\delta M = -0.4$ MeV, in rough agreement with their earlier result. However, inclusion of the vertex corrections of $O(\alpha)$, which are neglected by Bassetto and Paccanoni, leads to the unsatisfactory result $\delta M = +0.8$ MeV. (auth)

11617 SUPERCONVERGENT DISPERSION RELATIONS AND I = 2 ELECTROMAGNETIC MASS DIFFERENCES OF HADRONS. Biswas, S. N.; Bose, S. K.; Datta, K.; Dhar, J.; Novozhilov, Yu. V.; Saxena, R. P. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 164: 1936-9(Dec. 25, 1967).

Explicit calculations are presented for the I = 2 electromagnetic mass difference between particles of a given isomultiplet using the superconvergent-dispersion-relation approach suggested by Harari. In particular, the electromagnetic mass differences are obtained: (i) $\pi^+ - \pi^0$, (ii) $\rho^+ - \rho^0$, (iii) $\Sigma^+ + \Sigma^- - 2\Sigma^0$, (iv) $N^{*++} + N^{*0} - 2N^{*+}$, and (v) $Y_1^{*+} + Y_1^{*-} - 2Y_1^{*0}$. The agreement with experiments is excellent. (auth)

11618 SCATTERING OF FAST ELECTRONS MOVING IN MAGNETIC FIELD. Dorofeev, O. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 90-5(July-Aug. 1967). (In Russian).

A problem on relativistic electron scattering on a spherically symmetric center of force in a homogeneous magnetic field was investigated. It was assumed that the initial electron state corresponds to motion along the field. (tr-auth)

11619 MONOENERGETIC BREMSSTRAHLUNG WITH LINEAR POLARIZATION CLOSE TO 100 PERCENT FROM THIN CRYSTAL TARGETS. Lutz, G. (DESY, Hamburg). Nuovo Cim. (10), 53A: 242-54(Jan. 1, 1968).

Mozley and de Wire (Nuovo Cimento, 27, 1281(1963)) have pointed out that bremsstrahlung from thin crystals can be monochromatized if one strongly collimates the photon beam. In recent papers it was shown that the linear polarization of uncollimated coherent bremsstrahlung can be raised if the crystal is oriented in such a manner that one gets the main contribution to the spectrum from one single reciprocal lattice point only. It is shown that by combining this method of orientation of the crystal with strong collimation one gets not only one dominating monoenergetic spike in the spectrum due to this single reciprocal lattice point, but that, in addition, the polarization of the spike is increased to a very high value. A simple procedure is given for deriving these spectra and their polarization from some "universal" curves for silicon and diamond crystals. An estimate is given of the photon intensity which can be reached by this method. (auth)

11620 LOW-ENERGY THEOREM CONNECTING WEAK-PION PRODUCTION AND TWO-PION PHOTO-PRODUCTION. Narayanaswamy, P.; Renner, B. (CERN, Geneva). Nuovo Cim. (10), 53A: 107-14(Jan. 1, 1968).

$(N^*\pi)$ photo-production from nucleons is connected to the matrix elements of the weak axial current between nucleons and $N^*(1236)$ states as a low-energy theorem by current algebras. Using predictions for these matrix elements, partly again from current algebras, the threshold cross section of $\gamma N \rightarrow \pi N^*$ is worked out, so providing a possible consistency test. (auth)

11621 POSITRON SCATTERING ON ELECTRON CONSIDERING COMPLEXIFICATION OF SPACE. Tsuong Wang Fi. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No, 4, 110-12 (July-Aug. 1967). (In Russian).

The formula for differential effective cross section of electron–electron scattering in the 8th-space was obtained previously by complexing the special coordinates and introducing isotopic time. The interaction Lagrangian for the above aspect is presented as a function including the ordinary and isotopic variables. Moreover, an invariance of the Minkowski subspace in the 8th space is assumed for elastic scatterings. The Lagrangian electromagnetic interactions are considered as $L_{int} = g\bar{\psi}(x,x)\Gamma^n\psi(x,x)A_n(x,x)$ which is invariant in relation to Lorentz conversion. The obtained equation for differential cross section for positron scattering on electron is further developed. (R.V.J.)

11622 THEORETICAL CALCULATIONS ON THE REACTIONS IN THE COLLISIONS OF ELECTRON AND POSITRON BEAMS. Altarelli, G. (Univ., Florence); de Gennaro, S.; Celeghini, E.; Longhi, G.; Gatto, R. pp VI.5.1-8 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E.

(eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The radiative conditions for interactions from collisions of electron and positron beams are treated. The interaction $e^+ + e^- \rightarrow \mu^+ + \mu^-$ was considered as a two-body type process produced by the exchange of a single photon. In order to calculate the bremsstrahlung correction, it is necessary to consider in detail the resolution of the apparatus relative to the photon emission. The region permissible for the motion of the nondetected photon has different forms in the symmetric case and the asymmetric case. This form depends on the energy and angular resolutions. In the asymmetric case, the scattering angle for each event is defined intrinsically beginning with the event observed with respect to one of the particles finally emitted. The contribution of high term orders was considered using the technique of renormalization groups. (tr-auth)

11623 RADIATIVE CORRECTIONS IN THE INFRARED FOR EXPERIMENTS ON BEAM COLLISIONS (ELECTRONS AND POSITRONS). Etim, E.; Pancheri, G.; Touschek, B. (CNEN, Frascati, Italy). pp VI.6.1-10 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26-30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The probability $d^4P(k)$, of a four-momentum loss in d^4k, is determined by applying the methods of statistical mechanics to the predictions of the Bloch and Nordsieck theorem. This theorem establishes that whereas the effect of radiation recoil emitted on the emitting particles can be neglected, the distribution of the number of photons is a Poisson distribution and that the mean number of photons of a given quantity of motion can be determined classically. A general formula for $d^4P(k)$ is given. The properties of the function are then considered. Useful approximations of the angular distribution of the momentum loss are given. (tr-auth)

11624 SYNCHROTRON RADIATION. Sokolov, A. A.; Ternov, I. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 10, 66-82(1967). (In Russian).

A brief review is given on classical and quantum theory of synchrotron radiation. The composition and angular distribution of synchrotron radiation polarization properties, quantum excitation effects of radial oscillations, quantum fluctuation effects in cyclic accelerators, the "macro-atom" problem, spin effects and induced synchrotron emission are discussed. 36 references are included. (R.V.J.)

11625 HIGH ENERGY ELECTROMAGNETIC INTERACTIONS AND FIELD THEORY. Levy, Maurice (ed.). Cargese Lectures in Theoretical Physics. New York, Gordon and Breach Science Publishers, Inc., 1967. 332p. $15.00 Hardbound, $5.00 Paperback.

Separate abstracts are prepared for the six lectures presented on high energy electromagnetic interactions and field theory. (L.B.S.)

For abstracts of individual lectures see: 11626, 11630, 11703, 11713, 11716, and 11717.

11626 ELECTRON SCATTERING. Schiff, L. I. (Faculte des Sciences, Orsay, France). pp 1-39 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

A study is made of the electromagnetic form factors of nucleons. The structure of the Rosenbluth formula is examined for electron scattering by nucleons, and for the process in the crossed channel which describes the annihilation of an electron-positron pair through one virtual photon. The process is generalized to the case of two virtual photon exchange, where certain characteristic effects on the cross section can be studied experimentally. The structure of the photon-nucleon-nucleon vertex is investigated in electron-deuteron scattering. Electron scattering on ^3H and ^3He is also investigated. (L.B.S.)

11627 LIFETIME FOR THE ELECTROMAGNETIC DECAY OF THE Σ^0-HYPERON. Stoler, David. New York, Yeshiva Univ., 1966. 91p.

Thesis.

The lifetime of the Σ^0 hyperon was calculated by means of dispersion relation techniques. Specifically the $(\kappa\bar{\kappa})$ intermediate state contribution was treated, using an existing calculation of the $(\pi\pi)$ contribution. Two sets of meson-baryon coupling constants corresponding to fully symmetric and broken SU(3) were used and the results for both cases are given. While there does exist several uncertainties regarding the final numerical results, it appears clearly, that the decay is quite sensitive to the $(\kappa\bar{\kappa})$ contribution. (Diss. Abstr.)

11628 ELECTROPRODUCTION IN PI MESONS AT HIGH ENERGY AND LARGE MOMENTUM TRANSFER. Vik, Robert Chester. San Diego, Calif., Univ. of California, 1967. 43p.

Thesis.

The inelastic scattering of an electron by a nucleon, accompanied by creation of a single pi meson (pion electroproduction), is considered as a function of $\underset{\sim}{k}^2$, the square of the three dimensional momentum transferred from the electron to the final pion nucleon system. At energies high enough that the pion nucleon center of mass energy is above the region of the $N^*(1238)$ resonance no complete cross section calculation exists, largely because the presence of inelastic channels makes the calculation difficult. However the effect of an important set of one particle exchange diagrams can be evaluated, and it is proposed that they provide a way of examining the qualitative behavior of the electroproduction cross section as a function of $\underset{\sim}{k}^2$. The cross sections in several partial waves, due to these diagrams, are evaluated and are compared with published experimental results at several energies. It is found that the S_{11} and P_{11} partial waves are likely to be important at large values of $\underset{\sim}{k}^2$ and at high energies. Furthermore the dependence of the cross section on $\underset{\sim}{k}^2$ in these partial waves is qualitatively like the dependence indicated by the experiments at 1512 MeV pion nucleon center of mass energy. (Disser. Abstr.)

Weak

Refer also to abstract 11987.

11629 (NP-17198) VOZMOZHNOSTI SOZDANIYA NEITRINNOGO PUCHKA OT PROTONOV V ENERGIEI 70 GeV. (The Possibilities for the Neutrino Beam From 70-GeV Protons). Alekseev, N. V.; Gershtein, S. S.; Markova, S. M.; Folomeshkin, V. N.; Shukeilo, I. A. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. 32p. (In Russian). (Stf/Sef/Svm/Sku-67-33-k).

The results of the computations of neutrino spectra which can be obtained from 70-GeV protons are presented. To increase the neutrino flux the focusing of mesons by a magnetic horn is considered. The effective variant of the focusing device was found and its main parameters given. The obtained results are of interest for the designing of the neutrino beam and carrying out of the experiments. (auth)

11630 HIGH ENERGY NEUTRINO REACTIONS. Meyer, Phillippe (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 117-69 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

A brief review is given of leptonic and semileptonic interactions. Information that can be obtained from neutrino experiments which were carried out at Brookhaven and CERN is examined under the following topics: the neutrino experiment; elastic neutrino scattering; form factors; elastic differential cross section; comparison with experiment of elastic cross section; lepton polarization; general theorems on inelastic neutrino scattering; single pion production by neutrinos; strange particle production by neutrinos; the intermediate boson; and intermediate vector boson production by neutrinos. (46 references.) (L.B.S.)

11631 ON THE PCAC HYPOTHESIS IN NUCLEI AND ITS PREDICTIONS FOR HIGH-ENERGY NEUTRINO CROSS SECTIONS. Loevseth, J.; Froeyland, J. (Univ. of Oslo). Nuovo Cim. (10), 53A: 1-17(Jan. 1, 1968).

Adler has proposed a test of the partially conserved axial-current (PCAC) hypothesis in high-energy forward inelastic neutrino reactions by relating the cross section to a corresponding pion cross section. The extension of Adler's result to the forward region is discussed and the relevant neutrino-nucleus cross section is calculated using Bell's optical model for virtual pions. The A-dependence is found to be close to that of cross sections for real pions. It is however pointed out that the formulation of PCAC in nuclear matter is ambiguous. A modified PCAC which gives neutrino cross sections proportional to A also in the forward direction is found to be more reasonable and is also favored by the CERN HLBC data. The detailed form of PCAC will also have consequences for other weak processes in nuclei. (auth)

11632 SUPERCONVERGENCE SUM RULES FOR RADIATIVE DECAYS OF MESON RESONANCES. Calucci, G.; Verzegnassi, C. (Univ., Trieste, Italy). Nuovo Cim. (10), 53A: 187-200 (Jan. 1, 1968).

The process $\gamma\pi \rightarrow \rho\pi$ for which three sum rules are derived is considered from high-energy behavior hypothesis. Combining these sum rules with the analogous ones for the process $\rho\pi \rightarrow \rho\pi$

the electromagnetic widths of the ω, A_1, A_2 resonances, and the S-wave/D-wave ratio for the $A_1 \rightarrow \rho\pi$ decay are determined. Some features of gage invariance and superconvergence requirements are discussed: in particular, some already known low-energy theorem consequences are derived, e.g., the sum rule obtained by Harari for Compton scattering. This last one and the Cabibbo and Radicati sum rule are used to select the best values of the ω, A_1, A_2 electromagnetic widths. (auth)

11633 ON A RELATION BETWEEN THE DECAYS $\pi^0 \rightarrow 2\gamma$ AND $\pi^+ \rightarrow e^+ + \nu + \gamma$. De Baenst, P.; Pestieau, J. (Univ., Louvain, Belg.). Nuovo Cim. (10), 53A: 137-45(Jan. 1, 1968).

A connection between the decays $\pi^0 \rightarrow 2\gamma$ and $\pi^+ \rightarrow e^+ + \nu + \gamma$ is established, using reduction formalism, G-parity and commutation relations between the electromagnetic field and hadronic currents. (auth)

11634 THE STABILITY OF $^6Li_\Lambda$. Lovitch, L. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Rosati, S.; Dalitz, R. Nuovo Cim. (10), 53A: 301-8(Jan. 1, 1968).

It is considered theoretically which are the conditions that must be satisfied in order that $_\Lambda Li^6$ have a bound state. The conclusion is that such a bound state would not be expected to occur on the basis of present knowledge of Λ hypernuclei unless there were an exceedingly large violation of charge symmetry in the ΛN interaction. It is concluded that a stable state for $_\Lambda Li^6$ would require a much larger charge-symmetry breaking potential than it is reasonable to expect from electromagnetic corrections to the ΛN potential. The discussion indicates that there should exist an unstable hypernuclear state $_\Lambda Li^6$ with decay mode $_\Lambda Li^6 \rightarrow p + {}_\Lambda He^5$ probably about 0.5 MeV above this threshold. This would appear as quite a sharp resonance in the $p - {}_\Lambda He^5$ system. (J.F.P.)

11635 SPIN DEPENDENCE OF NEUTRINO–NUCLEON INTERACTIONS WITH MUON PRODUCTION. Kerimov, B. K.; Kasumov, Yu. M. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 113-15(July-Aug. 1967). (In Russian).

Cross sections of neutrino–nucleon interactions were calculated previously considering longitudinal polarization of the finite nucleon within the limits of the four-component and two-component double neutrino theory. The predictions for the two theories are analyzed in relation to the two types of neutrino (ν_e and ν_μ) and to the ambiguities in weak-interaction physics. In the two-component theory with V–A interactions the electron and muon neutrino have an identical chirality and e^-, μ, ν_e, and ν_μ are leptons permitting the reaction: $\nu_\mu + n \rightarrow p + \mu^-$ and $\bar{\nu}_\mu + p \rightarrow n + \mu^+$. In the four-component theory the muon and electron neutrino have opposite chirality and e^-, μ^+, ν, and ν' are leptons with the reaction $\bar{\nu}' + n \rightarrow p + \mu^-$ and $\nu' + p \rightarrow n + \mu^+$, which means that in the four-component theory an antineutrino (neutrino) of muon type $\bar{\nu}'(\nu')$ can react with a neutron (proton) forming a μ^-–meson (μ^+–meson). The above reactions are analyzed and measurement of the angular distribution of muons and the degree of longitudinal polarization of neutron (proton) of the recoil of the neutrino–neutron interactions permitted a determination of whether the muon current ($\bar{\mu}\nu'$) interacts with nucleon current by means of V + λA bond and, also, confirmed the prediction of the four-component neutrino concerning the chirality of muon neutrino ($\bar{\nu}' = \nu_R$) and antineutrino ($\bar{\nu}' = \bar{\nu}_L$). (R.V.J.)

11636 GENERAL PROPERTIES OF THE ELECTROMAGNETIC CORRECTIONS TO THE BETA DECAY OF A PHYSICAL NUCLEON. Sirlin, A. (New York Univ.). Phys. Rev., 164: 1767-75(Dec. 25, 1967).

Some general properties of the electromagnetic corrections to the β decay of a physical nucleon, that is, a nucleon in the presence of strong interactions, are discussed. An attempt is made to isolate and determine general properties which are independent of the details of the strong interactions and the assumptions about the existence of the intermediate boson. The method used consists essentially in separating out in a finite and gauge-invariant manner all the terms of order 1/k in the hadronic covariants, and then examining properties of the other contributions. Under some general and plausible mathematical assumptions, it is shown that all the terms of order α in the correction factor to the electron spectrum which explicitly depend on the electron energy E and the electron mass m can be rigorously computed, in spite of the complications of the strong interactions, provided that contributions of relative order $\alpha q/M$, $\alpha(E/M)\ln(M/E)$, and $\alpha v_N/c$ are neglected. In particular, the electromagnetic correction of order α to the shape of the allowed electron spectrum is given by a single universal function $g(E,E_m,m)$ of E, m, and the end-point energy E_m; this function is independent of the details of the strong interactions and the assumption that the weak interactions are mediated by an intermediate boson. It is furthermore independent of the ratio M_{GT}/M_F, and is physically significant, particularly if applied to nuclear β decays with $E_m/m \gg 1$. These propositions do not preclude the existence of model-dependent terms which give contributions to the lifetime. No attempt is made here to evaluate these quantities, but their role on the physical observables is discussed. It is pointed out that, aside from the electron spectrum, there are other observables for which the corrections can be evaluated in a model-independent manner. This assertion is illustrated by giving the expression for the virtual radiative corrections of order α to the longitudinal polarization of the electron in allowed transitions. The contribution of the universal function $g(E,E_m,m)$ to the lifetime is briefly discussed. The validity of the vector and axial-vector theory of weak interactions is implicitly assumed. (auth)

11637 PARTIALLY CONSERVED CURRENTS AND WEAK FORM FACTORS. Nieh, H. T. (State Univ. of New York, Stony Brook). Phys. Rev., 164: 1780-4(Dec. 25, 1967).

A modification of the Goldberger-Treiman relations (for G_A and for the induced pseudoscalar G_P) is obtained by assuming, in addition to the hypothesis of partially conserved axial-vector currents, that the matrix element of the axial-vector current between two nucleon states is dominated by the $A_1(1080)$ and π. This yields a more detailed structure of the weak form factors. The result is discussed. Extending this line of thought to the case of strangeness-changing currents, which is assumed to be "partially conserved," corresponding expressions for the strangeness-changing induced scalar and pseudoscalar form factors are obtained. A relation is obtained relating the induced scalar coupling to the K_{13} form-factor ratio $\xi = f_-(0)/f_+(0)$. These results are useful in a detailed study of the Cabibbo theory. A value for the K_{13} parameter ξ is obtained by combining our results with the soft-pion current-algebra result of Callen and Treiman. It ranges from -0.15 to -0.10, depending on the experimental value of f_K/f_π. (auth)

11638 p-WAVE INTERACTIONS IN τ DECAY. Schult, R. L. (Univ. of Illinois, Urbana); Barbour, I. M. Contract N00014-67-A-0305-0005. Phys. Rev., 164: 1791-4(Dec. 25, 1967).

The effect of final-state s- and p-wave interactions on the spectra in $K \rightarrow 3\pi$ decay was calculated using the Faddeev formalism derived in an earlier paper. In this model, p waves are not produced directly by the weak interaction but only by the recoupling of pion pairs in the multiple scattering series. For large s-wave scattering lengths ($\sim 1.0 m_\pi^{-1}$), the p state has very little influence on the spectrum, and a fit to the experimental spectra requires $a_0^2 > a_0^0$. However, for small s-wave scattering lengths ($\sim 0.2 m_\pi^{-1}$) the p wave can become dominant, and fits to the data can be achieved with $a_0^2 < a_0^0$. These p-wave-dominant solutions are cutoff-sensitive, so that there is no unique fit. The final-state interaction phase is also calculated. (auth)

11639 PARITY-VIOLATING NONLEPTONIC DECAYS OF HYPERONS. Hara, Yasuo (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 164: 1844-7(Dec. 25, 1967). (BNL–11686).

The SU(3)-symmetric Chew-Low static model is applied to the parity-violating nonleptonic decays of hyperons. The decay of the pseudoscalar meson octet into two pseudoscalar mesons is the driving force of the nonleptonic decays of hyperons. The agreement of the result with experiments is satisfactory. Our result satisfies the Lee-Sugawara relation. The bootstrap model is also applied to the zero pseudoscalar-meson four-momentum limit of the nonleptonic decays. The hyperon nonleptonic decay amplitudes at q_μ (pseudoscalar meson) = 0 are found to be the same as those with pseudoscalar mesons on the mass shell except for a numerical constant common to all amplitudes, if the d/f ratio of the baryon-octet–pseudoscalar-meson-octet coupling is 1.5–2.0. The $|\Delta I| = 3/2$ part of the hyperon decay amplitudes is predicted to be small. (auth)

11640 OCTET DOMINANCE IN THE CURRENT–CURRENT FORM OF THE WEAK INTERACTION. Simmons, Walter A. (Purdue Univ., Lafayette, Ind.). Phys. Rev., 164: 1956-8 (Dec. 25, 1967).

It is shown that the f/d ratios of the vector and axial-vector currents play an important role in octet dominance within the the current–current theory of weak interactions. (auth)

11641 NEUTRINO EXPERIMENTS AND THE QUESTION OF LEPTON CHARGE CONSERVATION. Pontekorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 1717-25(Nov. 1967). (In Russian).

Experiments are compatible with quite large lepton charge violations. Various experiments which would be capable of revealing such hypothetical violations are discussed. It is shown that the most sensitive experiments are the search for the process $\mu \rightarrow e + \gamma$ and especially the search for $\nu \rightleftharpoons \bar{\nu}$ and $\nu_e \rightleftharpoons \nu_\mu$ oscilla-

tions. A finite value of the neutrino mass could be connected with PC violations and with electrical (and magnetic) neutrino dipole moment. Astronomical applications of $\nu \rightleftharpoons \bar{\nu}$ oscillations are indicated. (auth)

11642 RADIATIVE CORRECTIONS TO HIGH-ENERGY "ELASTIC" NEUTRINO-NUCLEON SCATTERING. Abate, Joseph. New York, New York Univ., 1967. 100p.

Thesis.

The radiative corrections to order α were calculated for the high-energy "elastic" scattering processes: $\nu + n \rightarrow \rho + \mu^-$ and $\bar{\nu} + \rho \rightarrow n + \mu^+$. The calculation was carried out by making use of techniques that were developed by Yennie et al., for dealing with radiative corrections to high-energy electron scattering processes. The main feature of the treatment is the separating out and the explicit calculation of the "external radiative corrections" which are obtained by considering emission and absorption of photons (real or virtual) from external lines in the approximation of setting the photon four-momentum equal to zero in the original interaction vertices. This means that the nucleon weak interaction vertex is affected only by the over-all lepton momentum transfer. The corrections are explicitly given for the laboratory system, assuming the incoming neutrino energy is greater than one BeV. The inelastic part of the radiative corrections, that is, the contributions of processes in which soft photons are emitted, were handled assuming an experimental setup in which the energies of both final particles are measured. Then, the value of the total uncertainty in energy is assigned as the maximum energy of an unobserved photon. The tabulation of numerical results gives the cases where the maximum energy of an unobserved photon is taken to be one and five per cent of the incoming neutrino energy. It is found that the corrections are of the order of one to ten per cent and are negative so as to diminish the cross section. The results contain some terms which depend on the ultraviolet cutoff Λ, thereby providing an ambiguity in the calculation. However, it is found that in the interval $M \leq \Lambda \leq 4M$ (where M is the nucleon mass), the ambiguous terms are of such a magnitude that they contribute little to the total corrections in the energy region where the corrections are important. For example: at zero momentum transfer with the neutrino laboratory energy equal to 4 BeV and the maximum energy of an unobserved photon given at 40 MeV, the corrections to the differential cross section vary from -3.72% to -2.76% as Λ varies from M to 4M. It is found, a posteriori, that the major contribution to the corrections is independent of the nature of the form of the weak interaction since it is simply a factor times the uncorrected cross section, and it is completely unambiguous since it does not depend on the ultraviolet cutoff. Therefore, in that sense, it may be considered a "universal" contribution. It is tabulated numerically as a function of the incoming neutrino energy and the four-momentum transfer in the laboratory system. Some interesting analytical features of this contribution are also discussed. It is pointed out that by adding the electromagnetic interaction to the weak process, the point structure of the lepton current is lost. Therefore, any consequences concerning the cross section derived from a local leptonic current hypothesis are not true for the results. One may view this deviation from a strict local point structure of the lepton current as arising from an effective nonlocal Lagrangian. (Disser. Abstr.)

11643 TOPICS IN THE THEORY OF WEAK INTERACTIONS. Lessor, Delbert Leroy. Manhattan, Kan., Kansas State Univ., 1967. 123p.

Thesis.

The effects of nonzero neutrino masses on the weak interactions of leptons are considered using the local four-Fermion V-A interaction scheme. The differential transition rates with nonzero neutrino masses for polarized muon decay with only neutrino spins unobserved, neutrinos totally unobserved, and only electron momenta observed are given. An expression agreeing with that of K. Nagy is obtained for the electron energy spectrum of unpolarized muons decaying at rest. The effects of nonzero neutrino masses on muon decay are observed to be small. An invariance argument for the form of the matrix element for weak decay of charged pions is given; the branching ratio into the two lepton modes and the polarization of the emitted leptons are then calculated as a function of muon neutrino mass. The branching ratio obtained here also agrees with that of K. Nagy. Neither the experimental branching ratio nor the lepton polarization is sufficiently accurate to determine the muon neutrino mass. Neutrino beam calculations are performed, and the unsatisfactory asymptotic linearity of cross sections with high neutrino energy in the local four-Fermion V-A theory is noted. Violation of Yamaguchi's extension of Pomeranchuk's Theorem is also noted. Neither of these features is altered by a nonzero neutrino mass. Some of the divergent expressions which mar the local V-A theory are exhibited. Alternate muon number or particle and antiparticle assignments are considered, and the altered local Hamiltonian to obtain the same lepton weak interaction parameters is exhibited. The intermediate vector boson hypothesis is discussed briefly. A nonlocal Hamiltonian for weak interactions is proposed. Causality properties of this interaction are examined. The difference between Wick and Dyson ordering motivates the postulation of an S operator which is shown to agree under certain circumstances with the S arising from the nonlocal Hamiltonian theory. The postulated S using the Wick product is computationally more convenient. A nonlocality function whose Fourier transform vanishes as reciprocal momentum squared is shown to render finite some matrix elements which in the corresponding local four-Fermion theory are divergent. (Disser. Abstr.)

Strong (General)

11644 (ITF-67-13) DISPERSION SUM RULES IN THEORY OF STRONG INTERACTIONS. Matveev, V. A.; Soloviev, L. D.; Struminski, B. V.; Tavkhelidze, A. N.; Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 73p. Dep.

The methods for the derivation of dispersion sum rules in strong interaction theory and the results obtained due to these rules are reviewed. The definition and properties of currents in local field are discussed, and the local vector and axial-vector currents of hadrons and their isotopic and unitary structure are considered. The principal methods of the dispersive sum rule derivation, the use of dispersive sum rules to investigate certain physical processes under the assumption of the isotopic invariance of strong interactions are covered. In particular, the Cabibbo–Radicati and the Adler–Weisberger sum rules are derived. The dispersion sum rules for meson scattering and in connection with SU(3) symmetry are discussed. Finally, an investigation is made of the problem of the saturation of sum rules by the nearest resonances, and a possible modification of the sum rules due to the high-energy contributions to dispersion sum rules is presented. (J.F.P.)

11645 VERY HIGH-ENERGY SCATTERING OF STRONGLY INTERACTING PARTICLES. Van Hove, L. (CERN, Geneva). pp 63-111 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

A qualitative description is given of the experimental information on high-energy scattering, giving references to the most relevant literature. The remaining topics include the treatment of high-energy expansion of two-particle collision amplitude at finite momentum transfers; the Regge pole model; diffraction as shadow scattering, and the quark model of high-energy processes. 78 references. (L.B.S.)

11646 QUARK MODELS. Squires, Euan J. (Univ. of Durham, Eng.). pp 380-406 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

Following a brief discussion on unitary triplets, the questions of whether quarks exist and whether they should be regarded as "elementary" are considered. One of the basic assumptions of all quark models is discussed in detail, namely, that the amount of admixture of many quark (and antiquark) channels is relatively small. This topic is treated by means of a simplified dynamical model. Two possible extreme types of quark models are discussed—the "long range" and "short range" models. A review is given of the types of predictions that can be made from quark models, and a comparison is made of some of these predictions with experiment. (L.B.S.)

11647 RAPIDLY DECREASING FORM FACTORS AND INFINITELY COMPOSITE PARTICLES. Stack, John D. (Univ. of Illinois, Urbana). Contract N00014-67-A-0305-0005. Phys. Rev., 164: 1904-11(Dec. 25, 1967).

The problem of understanding the asymptotic behavior of hadron electromagnetic form factors is considered. It is shown that if the hadrons form a bootstrap, each hadron must be a bound state of an infinite number of particles, or infinitely composite. A simple model containing an infinitely composite particle is constructed, and the form factor of the particle is calculated. The form factor decreases exponentially for large spacelike momentum transfers. On the basis of this, it is suggested that a criterion for a bootstrap should be exponentially decreasing form factors for all hadrons. (auth)

11648 ELECTROMAGNETISM AND AN SU(2) BOOTSTRAP MODEL. Golowich, E. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 164: 1912-18(Dec. 25, 1967).

A study is made of the effect of electromagnetism on a bootstrap model of hadron dynamics which contains only the particles N, $N^*(1236)$, π. The Bethe–Salpeter equation is used to generate isospin-invariant bootstrap equations which, when perturbed by electromagnetic processes, yield solutions dominated by isotensor

($\Delta T = 2$) effects. Consequently, it is concluded that the neutron-proton mass difference can not be understood by a model containing just these particles. (auth)

11649 ARE QUARKS REALLY HEAVY? Papastamatiou, N. J. (Syracuse Univ., N. Y.). Phys. Rev., 164: 1784-6(Dec. 25, 1967).

Superconvergence relations for quark-antiquark elastic scattering and quark-antiquark scattering to 0^- mesons are derived and saturated with S-wave quark-antiquark states. It is found that the masses of the vector mesons are the sum of the masses of the constituent quarks. A high symmetry of quark-antiquark couplings to 0^- and 1^- mesons is also found. (auth)

11650 PION DOMINANCE AND THE ADLER–WEISBERGER RELATION. Halliday, I. G.; Landshoff, P. V.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Phys. Rev., 164: 1834-5 (Dec. 25, 1967).

Although the application of pion dominance of the divergence of the axial current to the derivation of the Adler–Weisberger relation involves what is at first sight a fairly innocent assumption, a closer examination reveals that if it is valid the constraint imposed on the structure of the theory is not trivial. (auth)

11651 KINEMATIC CONSTRAINTS FOR INFINITELY RISING REGGE TRAJECTORIES. Brower, Richard C.; Harte, John (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 164: 1841-4(Dec. 25, 1967). (UCRL–17613).

A kinematic constraint on the energy dependence of infinitely rising Regge trajectories is established. Under quite general conditions it is shown that asymptotically $\alpha(s) \leq Cs^{\frac{1}{2}}$, provided that certain channels couple to high-spin Regge recurrences. The implications of this result for dynamical models of ever-rising trajectories and for the decay rates of resonances are discussed in the light of experimental indications that $\alpha(s) \sim Cs$. (auth)

11652 STRONG-COUPLING SOLUTION OF THE LEE MODEL. North, Gerald R. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-2171. Phys. Rev., 164: 2056-8(Dec. 25, 1967). (NYO–2171-229).

The Lee model isobar states are derived for large bare coupling ($Z \to 0$) by the methods of old-fashioned strong-coupling theory. There is one isobar in each sector with energy $\propto n\,(n-1)/g_0^2$, where n is the maximum number of mesons allowed in the sector. Renormalization constants are also presented for all sectors. (auth)

11653 QUARK MODEL AND THE BETHE–SALPETER EQUATION. SPINLESS QUARKS. Pagnamenta, A. (CERN, Geneva). Nuovo Cim. (10), 53A: 30-47(Jan. 1, 1968).

An accurate numerical solution of the Bethe-Salpeter equation for a strongly bound quark-antiquark system with a pure Yukawa kernel is presented and discussed. Only scalar quarks bound by scalar-meson exchange are considered. It is shown that s-wave bound states of meson mass can be obtained by adjusting the coupling constant. The average three-momentum of the quarks is found to be comparable to their mass. This necessitates relativistic treatment. Bound states of higher angular momentum are found but are too massive to be interpreted as known mesons. This might suggest that only s-wave quarks need to be considered in dynamical meson models and that mesons of higher spin may be formed more likely from multiquark systems. The exact Bethe-Salpeter spectrum is compared with those obtained from the Schrödinger equation and from the Blankenbecler-Sugar equation. (auth)

11654 EFFECTS OF UNITARY SYMMETRY UPON MESON PRODUCTION IN PROTON–ANTIPROTON ANNIHILATION. Ponzini, Robert Gordon. East Lansing, Mich., Michigan State Univ., 1967. 106p.

Thesis.

A theoretical investigation of meson production from proton-antiproton annihilation at total center-of-mass energies in the range 1.88 to 3.00 BeV is carried out. The Fermi statistical model is applied and is generalized, from an SU_2 invariant form, to include invariance under the transformations of the group SU_3. The calculations were done using the CDC 3600. Phase space integrals were obtained with a relative error of less than 6% using a Monte Carlo technique. All combinations of mesons from the $J = 0^-$, 1^-, and 2^+ nonets, which are allowed by conservation laws, are included as possible final states. The calculation of the SU_3 statistical weights became increasingly complex with increasing particle multiplicity. It was therefore necessary to limit final state multiplicities to six or less particles under the assumption of SU_3 invariance. This placed an upper limit of approximately 2.5 BeV upon the energies which could be considered in this case. The SU_3 weights are tabulated. The SU_2 weights are much easier to calculate so that, in this case, final states of up to ten particles and energies of up to 3.0 BeV are considered. The results indicate that no substantial improvement is made by the generalization from SU_2 to SU_3 invariance or by the inclusion of the resonances comprising the vector and tensor nonets. Furthermore, it is still necessary to introduce unphysically large volume parameters into the model in order to obtain results consistent with experiment, a common difficulty in statistical model calculations. However, the theory adequately reproduces experimental results for pion distributions, kaon production rates and charged prong distributions at a number of energies. (Diss. Abstr.)

11655 SOME QUARK MODELS OF ELEMENTARY PARTICLES. Horwitz, Paul. New York, New York Univ., 1967. 122p.

Thesis.

Starting from the two-body Dirac equation with a static, local square well potential, the behavior of the total bound state energy, was examined as a function of potential strength, for a system of two spinor particles. For scalar, vector, and axial vector coupling, and unequal mass particles, it is found that there do not exist tightly bound solutions of this equation which have the physically desirable property of approaching a state of two free, positive energy spinors as the potential is adiabatically turned off. For tensor coupling, tightly bound solutions do exist if the potential is sufficiently strong. No bound state solutions exist at all for pseudoscalar coupling. Using a non-covariant reduction of the Bethe-Salpeter equation for a quark and an antiquark interacting through exchange of a massive vector field, in the ladder approximation, and representing the interaction by a separable S-wave potential, the wavefunctions of the $^1S_0$ and $^3S_1$ states are found, which are identified with the physical π and ρ mesons, respectively. Assuming the same coupling constant for both states, the π-ρ mass splitting has the right sign, but is too large, for all values of the quark mass. The value of the $^1S_0$ wavefunction at the origin gives the value of the pion lifetime. The experimental value is obtained for a quark mass of 3.3 BeV. A similar calculation of the ρ-γ coupling constant diverges. (Diss. Abstr.)

Strong (Baryon No. = 0)

Refer also to abstracts 11686, 11688, 11706, and 11708.

11656 FINITE-ENERGY SUM RULES AND BOOTSTRAPS. Freund, Peter G. O. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev. Lett., 20: 235-7(Jan. 29, 1968). (COO–264-411).

By saturating finite-energy sum rules even at high energies by narrow resonant states, the couplings and the corresponding decay rates of these high resonant states to lower mass particles can be determined in a bootstraplike manner. (auth)

11657 QUARK-MODEL COUPLINGS AND STRONG DECAYS OF TENSOR AND AXIAL-VECTOR MESONS. Mitra, A. N.; Srivastava, Prem P. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 164: 1803-5(Dec. 25, 1967).

The quark-model couplings of tensor, axial-vector, and scalar mesons to PP and PV meson states were evaluated under the assumption that the former have the $Q\bar{Q}$ structures $^3P_{0,1,2}$ and $^1P_1$. The results for the strong decay widths for the known modes are in rather good agreement with observations. (auth)

11658 CURRENT-ALGEBRA CALCULATION OF HARD-PION PROCESSES: $A_1 \to \rho + \pi$ AND $\rho \to \pi + \pi$. Schnitzer, Howard J. (Brandeis, Univ., Waltham, Mass.); Weinberg, Steven. Phys. Rev., 164: 1828-33(Dec. 25, 1967).

New techniques are developed for treating the n-point functions of currents, which are interrelated by means of Ward identities obtained from the equal-time current commutation relations. The n-point functions are sorted out so as to define proper vertices which describe the reactions of particles of definite spin. A meson-dominance assumption is made by approximating the proper vertices by simple polynomials in momenta, with the coefficients determined by the Ward identities. The method is discussed in detail for $n = 3$ and the currents of chiral $SU(2) \times SU(2)$, and then applied to the decay processes $A_1 \to \rho + \pi$ and $\rho \to \pi + \pi$. (auth)

11659 UNITARITY CORRECTIONS TO CURRENT-ALGEBRA CALCULATIONS OF THE s-WAVE PION–PION SCATTERING LENGTHS. Kang, Kyungsik; Akiba, Tomoya (Brown Univ., Providence,). Contract AT(30-1)-2262. Phys. Rev., 164: 1836-40(Dec. 25, 1967). (NYO–2262TA-160).

A method of imposing unitarity on the amplitude obtained from current algebra is examined as a possible extrapolation procedure for the calculation of the s-wave pion-pion scattering lengths. This

method consists of two steps: The current-algebra result is incorporated to fix the amplitude at the symmetry point in the unphysical region, and the dispersion relation based on rigorous grounds is used to extrapolate up to the physical threshold. This procedure allows us to derive a set of exact sum rules for the s-wave scattering lengths which enables us to estimate the unitarity corrections to the current-algebra calculations. (auth)

11660 FORMAL RECONSTRUCTION OF THEORY FROM EXPERIMENT. **Halpern, M. B. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 164: 1878-86(Dec. 25, 1967).**

In large classes of models, it is shown formally how to reconstruct canonical field theories of the strong interaction in terms of electromagnetic, weak, and gravitational scattering data (the currents and the stress-energy-momentum tensor). (auth)

11661 MULTICHANNEL BOOTSTRAP CALCULATION OF THE VECTOR-MESON PARAMETERS USING A RELATIVISTIC LIPPMANN–SCHWINGER EQUATION. **Boguta, J.; Wyld, H. W. Jr. (Univ. of Illinois, Urbana). Contract 00014-67-A-0305-0005. Phys. Rev., 164: 1996-2000(Dec. 25, 1967).**

A multichannel bootstrap calculation of the vector mesons is performed, using a relativistic Lippmann–Schwinger equation. The vector mesons are obtained as resonances in the scattering of pseudoscalar mesons by pseudoscalar mesons, the potential between the two pseudoscalar mesons being taken as that due to vector-meson exchange. The on-shell potential is calculated using the usual Feynman rules, assuming that the coupling constants satisfy SU(3). Input parameters are taken from experiment. The potential is extrapolated off-shell, and the resulting Schroedinger equations are solved exactly. The input ρ-meson width Γ_ρ^{in} is taken to be 105 MeV, and the cutoff is so chosen that the output mass is equal to the input mass. With this choice of parameters, the following results are obtained: $\Gamma_\rho^{out} = 134$ MeV, $\Gamma_{K^*}^{out} = 51$ MeV, $m_{K^*}^{out} = 933$ MeV, $\Gamma_\varphi^{out} = 2.4$ MeV, $m_\varphi^{out} = 1009$ MeV. (auth)

11662 PADE-APPROXIMANT CALCULATION OF $\pi-\pi$ SCATTERING. Copley, L. A. (Univ. of Toronto); Masson, D. Phys. Rev., 164: 2059-62(Dec. 25, 1967).

Encouraged by the results of potential scattering, the Padé method of summing the Born series is applied to $\lambda\phi^4$ theory. The results of the third-order calculation are compared with previous work, both theoretical and experimental. (auth)

11663 EQUIVALENT POTENTIAL IN $\pi\pi$ SCATTERING AND ρ BOOTSTRAP. Das, J. N. (Calcutta Univ.). Nuovo Cim. (10), 53A: 24-9(Jan. 1, 1968).

Parameters for the ρ meson are calculated using Balâzs' "equivalent potential approach" with closer approximation. In earlier bootstrap calculations the reduced width came out several times larger than the experimental value. In this calculation the value, 0.13 is obtained for the reduced width, amazingly close to the experimental value 0.16. (auth)

11664 THE J = 1, I = 1, $\pi-\pi$ AMPLITUDE IN AN OPE MODEL. Banyai, L.; Marinescu, N.; Rittenberg, V. (Inst. of Physics, Bucharest). Nuovo Cim. (10), 53A: 309-12(Jan. 1, 1968).

An investigation is made of whether in the framework of the previously proposed OPE-type, crossing-symmetrical, simple-spectral representation for the scattering amplitudes one can describe correctly the low-energy J = 1, I = 1, $\pi-\pi$ partial wave; that is, if there exists a solution of the nonlinear integral equation of the simple-spectral density (obtained by imposing elastic unitarity on the amplitudes), which contains the well-known ρ resonance ($M_\rho = 760$ MeV, $\Gamma_\rho = 160$ MeV). Assuming a simple form for the involved spectral density, which takes into account the existence of the ρ resonance and the correct threshold behavior, it is observed that the partial wave amplitude verifies well the unitarity condition in a large interval. Besides this, assuming the existence of the required solution, the application of the zero-width approximation gives interesting results (especially for the scattering length). The results presented seem to indicate that in this crossing-symmetrical, unitarized OPE model there exists a solution, which, perhaps with the inclusion of the contribution of other partial waves, gives a description of the I = 1, J = 1 $\pi\pi$ amplitude in agreement with experimental data. (J.F.P.)

11665 AN APPLICATION OF THE ABSORPTION MODEL TO $p + \bar{p} \rightarrow B^* + \bar{B}^*$ REACTIONS. Ajduk, Z. (Warsaw Univ.). Acta Phys. Pol., 32: 909-26(Dec. 1967).

The differential cross section and the joint angular distribution of the resonances decay products were calculated using the absorption model with one spinless meson exchange for the reactions $p + \bar{p} \rightarrow B^* + \bar{B}^*$, where B^* is a baryon resonance of spin $\frac{3}{2}$. The numerical results for the $p + \bar{p} \rightarrow Y_1^{*+}(1382) + \bar{Y}_1^{*+}(1382)$ and $p + \bar{p} \rightarrow N_{33}^{*+}(1236) + \bar{N}_{33}^{*+}(1236)$ reactions at 5.7 GeV/c antiproton laboratory momentum are presented. (auth)

11666 DYNAMICAL MODEL OF $\omega-\phi$ MIXING AND THE VECTOR OCTET. Gupta, Satish K. Chicago, Illinois Inst. of Tech., 1967. 146p.

Thesis.

The vector meson nonet is studied from an S-matrix viewpoint. There are two related aspects of the problem: (a) mixing, and (b) nonlinear effects. Mixing is described in an S-matrix scheme in which stable or unstable particle states are associated with eigenvectors of the inverse reaction matrix K^{-1}. A perturbation theory of the mixing of such states is developed, and compared with conventional discussions of mixing. The S-matrix approach shows that the connection between the mixing angle and coupling constant ratios is not as direct as is sometimes supposed. Nonlinear effects of mass differences are examined in a simple theory in which the $V(J^P = 1^-)$ mesons are produced by single vector meson exchange forces in the P-P scattering, where P denotes the 0^- octet. In the limit of pure SU(3) symmetry the vector mesons ρ, K^* and ϕ are regarded as members of the V octet. The breaking of SU(3) symmetry is introduced by taking the observed masses for the P mesons. The first order effect of P mass differences alone produces octet-type mass perturbations of the V resonances. An exact evaluation of the theory (avoiding a perturbation treatment of mass differences) yields an I = 0 vector meson of 959 MeV. Thus, nonlinear mass difference effects produce a substantial deviation from the value 930 MeV obtained from the Gell–Mann–Okubo mass formula. To include the ninth vector meson in this dynamical model, a Castillejo–Dalitz–Dyson (CDD) pole is introduced in the denominator function of the I = 0 vector meson amplitude. The I = 0 amplitude now has two resonance poles, one produced by V exchange and identified with the physical ϕ meson and the other, arising from the CDD pole of the denominator function, is identified with the physical ω-meson. The residue and position of the CDD pole are adjusted such that the ϕ and ω resonances agree with the observed masses. The ω-ϕ mixing angle is then estimated from the ratio of $\omega K\bar{K}$ and $\phi K\bar{K}$ coupling constants. It turns out to be 29.5°, as compared to 39° for the conventional schemes of mixing. However, as our discussion of S-matrix mixing theory shows, there are some ambiguities in such a calculation of the mixing angle from coupling constants. The CDD pole can be regarded as a manifestation of a bound state in a channel coupled to the $K\bar{K}$ channel (say a P-V channel). The way in which such poles are induced is explained by a comparison of two-channel N/D equations and single-channel N/D equations including inelasticity parameters. A more complete two-channel model of mixing is outlined, in which the vector singlet is produced dynamically as a P-V composite state, and is coupled to the vector octet as a result of mass differences. In this extended model, several interesting questions can be investigated quantitatively; for instance, the validity of the perturbation treatment of mixing, the amount of mixing caused by mass differences alone, the relation of mixing angles to coupling constants, and the induction of the CDD pole in the P–P channel. (Disser. Abstr.)

11667 USE OF NUCLEAR TARGETS FOR INVESTIGATING BOSON RESONANCES. Melnikov, V. N.; Nikitin, Yu. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 878-80(Oct. 1967). (In Russian).

If nuclei with zero spin (S = O) and with zero isospin (T = O) such as ^{4}He, ^{12}C, ^{16}O, etc., are used as targets for investigating the mechanism of formation of boson resonances, and if the nucleus does not form an excited state as a result of the interaction, it is obvious that the amplitude spin structure is not very complex, and is determined only by a single invariant function. This result is obtained only on the basis of parity conservation in strong interactions and the requirement of relativistic invariance. The angular distribution of the decay products of the ρ-meson can be predicted from this result independently of the details of the interaction. Quantum numbers of boson resonances can be reliably determined from the characteristics details of the distribution of decay products and from the behavior of the differential cross section for the formation of vector mesons by pions on nuclei with S = T = O without excitation in the region of small generation angles. (TTT)

11668 EQUIVALENT-POTENTIAL METHOD FOR RELATIVISTIC SCATTERING. Finkelstein, Jerome Lee. Berkeley, Calif., Univ. of California, 1967. 57p.

Thesis.

The equivalent-potential method is generalized so as to permit calculation both of multichannel scattering and of certain scattering amplitudes of particles of nonzero spin. It is pointed out that amplitudes calculated by this method have correct dependence upon momentum transfer; it is argued that this feature may make the equivalent-potential method a better approximation to the unitarity iteration than is the N/D method. As examples, the $\pi\pi$, πK, and πN amplitudes are considered. For the first two of these cases it is found that the force due to vector meson exchange is far too small (it is suggested that inelastic effects may be quite important), but that if the input couplings are increased so as to reproduce the vector mesons, then 2^+ mesons are also produced, at roughly the

masses of the f°(1250), f'(1500), and K**(1405). In the πN case, with the potential given by nucleon and N*(1238) exchange, there are no free parameters in the calculation. The N* is then "predicted" at a mass of 1100 MeV. The nonresonant phase shifts also agree in a general way with the results of phase-shift analysis; in particular, the S_{11} scattering length has the correct sign, while N/D calculations produce the wrong sign. It is argued that this result indicates that the force due to iteration of the potential, included in this method but not in N/D, can be important. (Disser. Abstr.)

Strong (Baryon No. = 1)

Refer also to abstracts 11668 and 11706.

11669 (IFVE-STF-67-16-k) OSOBENNOSTI CHETYREKHUGOL'NYKH DIAGRAMM, SODERZHASHCHIKH REZONANSY V PROMEZHUTOCHNOM SOSTOYANII. (Singularities of Quadrangle Graphs With the Resonances in an Intermediate State). Anisovich, V. V. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. 17p. (In Russian). Dep.

The analytical properties of the quadrangle graph with two resonances in an intermediate state are considered. It is shown that this graph has a root singularity in the denominator which is close to the physical region of the reaction at W ≳ 2I (W is the total energy of the system, I is the resonance mass). The simple kinematic rule to find the position of this singularity is carried out. (auth)

11670 PION–NUCLEON PHASE SHIFT ANALYSIS. Donnachie, A. (CERN, Geneva). pp 330-79 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

Various approaches to pion-nucleon phase shift analyses are described in detail. Results are tabulated and discussed for T = 3/2 and T = 1/2 scattering. 45 references. (L.B.S.)

11671 LARGE-ANGLE pp SCATTERING AS AN EXPERIMENTAL TEST OF THE MINIMAL INTERACTION HYPOTHESIS. Chiu, C. B.; Harte, J.; Tan, Chung-I (Univ. of California, Berkeley). Contract W-7405-eng-48. Nuovo Cim. (10), 53A: 174-86(Jan. 1, 1968). (UCRL-17553).

Recently a lower bound of the general form ~ exp [Cs^{γ} ln s] has been suggested for the pp scattering amplitude at fixed angle, where $\gamma \geq 1/2$. A discussion is given of the characteristic features in the pp differential cross section should the minimal interaction hypothesis be valid. This form is compared with the experimental data for the cases $\gamma = 1/2$ and $\gamma = 1$, and it is found that the present data beyond the recently observed "break" in the 90° data are compatible with both cases although $\gamma = 1/2$ gives a slightly better fit to the data. Should the lower-bound behavior indeed saturate the amplitude in the large momentum transfer region, then the break can be attributed to the transition between the region where the lower bound contribution dominates and the smaller |t| region where specific t-channel exchange mechanisms are dominating. (auth)

11672 LOW-ENERGY PION–NUCLEON SCATTERING FROM CURRENT COMMUTATION RELATIONS AND PARTIAL CONSERVATION OF THE AXIAL-VECTOR CURRENT. Raman, K. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 164: 1736-51(Dec. 25, 1967). (NYO-3399-115).

Starting with current commutation relations and the hypothesis of partial conservation of the axial-vector current, relations are obtained for the pion-nucleon scattering amplitude considered to the second order in the energy variable ν. The structure-dependent contributions to the second-order terms in the matrix element involving the axial-vector currents are approximately by the direct and exchanged poles and resonances, particularly the N* resonances with spins 1/2 and 3/2. The contribution of the ρ meson to this matrix element is estimated to be small. Expressions are obtained for the P-wave scattering lengths and the S- and P-wave phase shifts at low energies. Numerical estimates are made for these and are compared with the available data; it is found that reasonable agreement with experiment can be obtained except for the P-wave scattering length $a[\Sigma^-]$ and the partial-wave amplitude $f[\Sigma^-]$. Some questions relating to the off-mass-shell extrapolation are discussed. The validity of the assumption made, in the usual derivation of the relations for the S-wave scattering lengths, that the terms of higher order in ν may be neglected is examined. It is suggested that at least for the isospin-symmetric scattering length this is not a good approximation, so that this scattering length cannot be obtained adequately by using only the current commutation relations and the hypothesis of a partially conserved axial-vector current. The scalar term arising from the commutator $[\dot{\varphi}^0(x), \phi(y)]$ is estimated; it is suggested that the contribution of this term is important and cannot be ignored. (auth)

11673 UNIFIED FORMULATION OF EFFECTIVE NON-LINEAR PION–NUCLEON LAGRANGIANS. Chang, P.; Gursey, F. (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 164: 1752-61(Dec. 25, 1967). (YALE-2726-504).

It is shown that a nonlinear Lagrangian model with chiral SU(2) ⊗ SU(2) symmetry for the π-N system proposed earlier, when complemented with an exact partially conserved axial-vector current term, provides a systematic and unified treatment of various phenomenological Lagrangians that are found in the recent literature. A detailed comparison is made for three special cases, showing agreement with current algebra and experimental data for π-N and π-π scattering lengths. (auth)

11674 SUM-RULE TEST OF AXIAL-CHARGE EQUAL-TIME COMMUTATION RELATIONS. Cordes, J. G.; Moffat, J. W. (Univ. of Toronto). Phys. Rev., 164: 1787-90(Dec. 25, 1967).

Starting from an equal-time commutation relation for the axial charges corresponding to elementary pions and nucleons, a sum rule is derived for $g_A = G_A/G_V$. This sum rule differs from the Adler–Weisberger relation in that it contains an integral over the energy and virtual pion mass of the total π-N cross sections. An estimate of the sum rule yields results for g_A close to those obtained by Adler and Weisberger. (auth)

11675 MESON–NUCLEON SCATTERING AMPLITUDE AT HIGH ENERGY. Tanaka, K. (Ohio State Univ., Columbus). Contract AT(11-1)-1545. Phys. Rev., 164: 1800-3(Dec. 25, 1967). (COO-1545-18).

The high-energy behavior $\nu \to \infty$ of the meson-nucleon scattering amplitude $A(\nu,t)$ is obtained by considering the contributions of the singularities of the commutator on the light cone, where ν is the incoming meson energy and t is the momentum transfer squared. For the possible dependences of the commutator on various invariants, a ν^n behavior stronger than $A \sim \nu^n$, $n > -1/2$ is found as $\nu \to \infty$. The $A \sim 1/\nu$ dependence emerges when the contribution from the commutator at the point $r = x_0 = 0$ on the light cone is taken. The Regge asymptotic behavior can be found if the singularity of the commutator on the light cone is expressible as a linear sum of an infinite number of derivatives of $\delta(x^2)$. (auth)

11676 TEST OF A SUPERCONVERGENT RELATION FOR MESON–BARYON SCATTERING. Graham, R. H.; Huq, M. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 164: 1820-1(Dec. 25, 1967). (NYO-3399-124).

The assumptions that (1) meson-baryon scattering amplitudes are dominated at high energies by Regge-pole exchange and (2) the residues characterizing the couplings of the Regge poles to the pseudoscalar mesons are SU(3)-symmetric lead to a superconvergent relation for the following combination of forward scattering amplitudes: $\{[T_{\pi^-p} - T_{\pi^+p}] + [T_{K^-n} - T_{K^+n}] - [T_{K^-p} - T_{K^+p}]\}$. Using experimental data on total cross sections and scattering lengths, this relation was tested and was found to be well satisfied for cutoffs on the integrals at 3, 5, and 20 BeV/c. (auth)

11677 PHYSICAL INTERPRETATION OF STATIC-MODEL PARAMETERS. Markley, F. Landis (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 164: 1848-58(Dec. 25, 1967). (UCRL-17502(Rev.)).

It is shown that an approximation to the static crossing matrix leads to a soluble model for the p_{11} and p_{33} πN scattering amplitudes in which the parameters are related to forces due to particle exchanges in the t channel. Reasonable values of these forces give properties of the nucleon bound state and the Δ resonance in good agreement with experiment. Further properties of the model are investigated. (auth)

11678 SUPERCONVERGENT DISPERSION RELATIONS AND PION–NUCLEON SUM RULES. Fayyazuddin; Hussain, Faheem (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 164: 1864-7(Dec. 25, 1967). (COO-264-391; EFINS-67-60).

Both the Adler–Weisberger sum rule and the spin-flip sum rule for pion-nucleon scattering were derived from superconvergent dispersion relations for weak amplitudes. The basic assumption is that the weak axial-vector–nucleon scattering amplitude $T^A_{\mu\nu}$ approaches the weak vector-nucleon scattering amplitude $T^V_{\mu\nu}$ at high energies. This allows superconvergent dispersion relations to be written for certain invariant amplitudes in the decomposition of $T_{\mu\nu} = T^A_{\mu\nu} - T^V_{\mu\nu}$. The hypotheses of partially conserved axial-vector current and of conserved vector current are then used to obtain pion-nucleon scattering sum rules while avoiding the ambiguities of the $q \to 0$ limit which is usually used in the current-algebra approach. Sum rules are also discussed for $G_A(q^2)$ away from $q^2 = 0$. (auth)

11679 COMPOSITE MODEL OF Σ. Martin, Anna J. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 164: 1868-77(Dec. 25, 1967). (UR-875-205).

A composite model of Σ as a bound state of $\Lambda\pi$ and $N\bar{K}$ is developed in terms of dispersion relations for form factors and an approximate Bethe–Salpeter equation. The effective constants of Σ to its constituents are predicted to be $8.7 \lesssim |g_{\Sigma^0\Lambda\pi^0}| \lesssim 10.7$ and $6.4 \lesssim |g_{\Sigma^0 pK^-}| \lesssim 7.9$ for the range $5.0 \lesssim |g_{\Lambda pK^-}| \lesssim 13.5$. The relative sign of $g_{\Sigma^0\Lambda\pi^0}$ and $g_{\Sigma^0 pK^-}$ is found to be opposite to the relative sign of $g_{pp\pi^0}$ and $g_{\Lambda pK^-}$. The model is further applied to a calculation of the on-shell electromagnetic form factors of the $\Sigma\Lambda$ system. Under the assumption of ρ dominance of the kaon isovector electromagnetic form factor, the $\Sigma\Lambda$ transition moment is determined to be $G_T(0) = g_{\Lambda pK^-} g_{\Sigma^0 pK^-} 0.9 \times 10^{-2}$ nuclear magnetons, whereas the form factor which would vanish in the limit of equal Σ^0 and Λ masses is two orders of magnitude smaller than the transition moment. (auth)

11680 RESONANCES AND KINEMATICAL PEAKS IN STRONG INTERACTIONS. Kramer, Ivan (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 164: 1887-1903(Dec. 25, 1967). (UCRL-17554).

Two peripheral models involving pion-nucleon reactions leading to a four-body final state are studied with particular respect to the predictions of the models for various three-particle invariant-mass distributions. These predictions are compared in detail with experimental results. The peaks in the mass distributions produced by the models, being accidents of the phase space, can not be associated with true resonances. The first model considered assumes a double two-particle resonance intermediate state. The second model contains one two-particle resonance and one virtual nucleon, and is used in fitting diffraction-scattering data. The entire formalism contained herein assumes arbitrary values for the center-of-mass energy and all masses involved. Thus, the results can easily be applied to a variety of reactions at different energies. The double-resonance model is applied to the reaction $\pi^+p \to \rho^0 N^{*2+} \to \pi^+\pi^-\pi^+p$ at 3.665 BeV/c and leads to the conclusion that there is no $T = 5/2$, $p\pi^+\pi^+$ resonance at 1.56 BeV. The diffraction-scattering model for the same reaction with a ρN intermediate state leads to peaks in the $\rho\pi$ invariant-mass distribution at around the mass of the A_1. (auth)

11681 REGGEIZATION OF PION EXCHANGE IN PRODUCTION PROCESSES. Frautschi, Steven; Jones, Lorella (California Inst. of Tech., Pasedena). Contract AT(11-1)-68. Phys. Rev., 164: 1918-28(Dec. 25, 1967). (CALT-68-135).

Couplings of the pion Regge trajectory are discussed. It is found that the kinematic factors prescribed by Wang must be supplemented by further kinematic terms. A simple physical interpretation is given for these additional terms. Our considerations lead to a model of pion trajectory couplings, which is in reasonable agreement with those experiments on vector- and tensor-meson production in which pion exchange is expected to dominate the forward peak. (auth)

11682 APPROXIMATION IN THE UNITARY CONDITION AND THE NEUTRAL SCALAR THEORY. Schlitt, D. W. (Univ. of Nebraska, Lincoln). Phys. Rev., 164: 1940-4(Dec. 25, 1967).

A method for the approximate determination of the elastic-scattering amplitude is applied to the static neutral scalar meson model of meson-nucleon scattering. It is shown that under appropriate conditions the approximate solution reduces to the exact solution in the static limit of the usual neutral scalar theory. The effect of recoil and more general static interactions on bound-state poles is discussed in relation to difficulties previously encountered in applying this approximation method to the equal-mass case. The latter difficulty can be avoided at the cost of other problems with the bound-state poles. (auth)

11683 KINEMATICAL CONSTRAINTS ON REGGE-POLE RESIDUES. Diu, B.; Le Bellac, M. (Faculte des Sciences, Orsay, France). Nuovo Cim. (10), 53A: 158-73(Jan. 1, 1968).

The problem of kinematical singularities and zeros of Regge-pole residues for processes with external spins is re-examined. The analyticity of the classical Mandelstam invariants introduce additional constraints into the Reggeization procedure proposed by Wang. The way these constraints work is described using simple examples, and the role of daughter trajectories discussed. These considerations are then applied to vector meson production and charged pion photoproduction. In particular, the sharp forward peak observed in this last process, as in neutron-proton charge exchange, is seen to raise a serious problem within the conventional Regge-pole model. (auth)

11684 SU_3 SYMMETRY IN STRONG COUPLING THEORY. Theumann, Alba Graciela. New York, Yeshiva Univ., 1966. 103p.

Thesis.

A study is made of the possible baryon "isobars," in strong coupling theory. The fundamental particles are assigned to definite representations of SU_3, the group of unitary, unimodular matrices of 3×3, and full invariance under this group is assumed. The problem can be solved in the "static model" approximation, in which the baryons are replaced by an extended source of mesons with internal degrees of freedom. The coupling of eight scalar mesons is considered, assigned in the usual way to the regular representation of SU_3, to a triplet of fundamental baryons. Except for their spatial properties, these mesons are the same as the known set of pseudoscalar mesons ($\pi^{+,-,0}$, $K^{+,-}$, $\bar{K}^0$, K^0, η) and, though unreal, the model gives some insight into the distribution of energy levels in SU_3 space. Scalar mesons couple in an S state, therefore the excited states obtained are all baryons of spin $1/2$. The problem is solved in chapter I, both in the semiclassical approximation and quantum mechanically. The results obtained in both cases coincide and the mass operator for the isobars is found to be proportional to the quadratic invariant of SU_3. The coupling of pseudoscalar mesons to baryons is analyzed in chapter II. Since pseudoscalar mesons couple in a P-state, the interaction depends not only on the SU_3 generators, but also on the spin of the baryons. This fact complicates the problem in the same way as pseudoscalar charged meson theory is complicated by the dependence of the interaction on spin and isospin generators. The problem is first solved in the semiclassical approximation, considering a triplet of baryons, as in chapter I. In II-b however, the solution is approached through the method of Goebel et al., which is based on the Chew and Low equation. The mass operator is, in this case, a linear combination of the quadratic invariants of SU_3 and SU_2. In the Appendix some classical results in strong coupling theory are explained from the point of view of techniques of group contraction. There also are included some results, obtained in the semiclassical approximation, for the coupling of an octet of mesons with an octet of fundamental baryons. (Disser. Abstr.)

11685 PERIPHERAL MODEL FOR Ξ^- ASSOCIATED PRODUCTION. James, Philip Benjamin. Madison, Wis., Univ. of Wisconsin, 1966. 93p.

Thesis.

A model is developed for application to production processes whose amplitudes are dominated by simple poles in the crossed u channel. The model is a single particle exchange model in which the amplitudes are modified to correct for initial and final state interactions through the use of the absorption model. The reaction $K^- + p \to \Xi^- + K^+$ is chosen for study as a process which one would expect to be a particularly clean example of a reaction dominated by u channel poles. The amplitudes for this process are constructed from pole terms representing single exchanges of Λ, Σ, $Y_1^*(1385)$, and $Y_0^*(1405)$ intermediate states. The absorptive corrections which are used in the model are derived from complex K^-p elastic scattering amplitudes which are determined from a Regge model of the elastic process. The coupling constants required in the calculation are determined in terms of known quantities by SU_3 symmetry. There is only one free parameter in the problem, namely the f/d ratio of the baryon-pseudoscalar coupling. A value of this parameter is predicted from the characteristics of the polarization computed with the model; this value is $f/d = 0.555$. This value agrees very well with previous determinations of the parameter. The model is found to lead to good agreement with many of the experimentally observed features of the cascade associated production process. Although quantitative agreement with experiment is obtained for beam momenta less than 1.5 BeV/c, at higher energies the magnitudes of the predicted cross sections diverge from observed values. However, polarizations and angular distributions at all energies qualitatively agree with available data. The results of this work indicate that the peripheral model is a reasonably good theory of processes which are dominated by u channel poles; the absorptive corrections computed from the complex elastic amplitudes improve the single particle exchange model to a large degree. The spin $3/2$ exchange terms in the amplitudes are found to have important consequences; it is felt that these terms should not be ignored in computations of this sort. (Disser. Abstr.)

11686 CALCULATIONS ON PRODUCTION REACTIONS USING THE ABSORPTIVE PERIPHERAL MODEL. Donohue, John Thomas. Urbana, Ill., Univ. of Illinois, 1967. 214p.

Thesis.

Calculations for the production and decay angular distributions of resonances produced in high energy collisions are presented. The peripheral model with absorption is used in the calculations; only two body meson induced reactions are treated. A comparison between the partial wave summation method, which is used here, and the earlier impact parameter formalism is given. The reaction $Kp \to K^*N$ is treated in detail, as both pseudoscalar and vector meson exchanges appear to be important. The possibility of determining the signs of coupling constants from a study of these reactions is discussed. Reactions in which two resonances are pro-

duced are analyzed for correlations between the decay angles of the resonances, and absorption model predictions for these correlations are compared with experiment. The problem of measuring the branching ratio for the decay $\rho^0 \rightarrow e^+e^-$ is discussed, first generally, and then using absorption model predictions to estimate the effect of the $\omega \rightarrow e^+e^-$ decay mode. The exchange of baryons is treated in an attempt to understand the small backward peaks in differential cross sections for some reactions. Absorption model predictions are found to be unreliable for these reactions. The details of the partial wave summation formalism for the exchange of mesons and baryons in meson induced reactions are given. (Disser. Abstr.)

Strong (Baryon No. ≥ 2)

11687 (JINR-P2-3597) K PERIFERICHESKOI MODELI PROTESSA N + N → N + N + π. (On the Peripheral Model of the N + N → N + N + π Process). Suslenko, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 39p. (In Russian). Dep.

A theoretical analysis of the NN – NNπ process was made. A convenient reference system is suggested. The limits of the invariant changes for the process of one-meson production are determined. The differential cross sections are calculated by means of the peripheral model and the critical analysis of the calculation methods, existing previously, is made. The comparison with experimental data is also made and the applicability of the peripheral model concepts at the energy region 500 to 700 MeV is shown. (auth)

11688 NUCLEON–NUCLEON AND NUCLEON–ANTINUCLEON CHARGE-EXCHANGE SCATTERING AND CONSPIRACY OF SINGULARITIES IN THE COMPLEX ANGULAR MOMENTUM PLANE. Huang, Kerson; Muzinich, I. J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 164: 1726-35(Dec. 25, 1967). (MIT–2098-349).

The experimental data on the reactions pn → np and $p\bar{p} \rightarrow n\bar{n}$ near the forward direction are analyzed for evidence of "conspiracy." From a comparison between the forward differential cross section of pn → np and the total cross sections for pp and pn, it is concluded that conspiracy exists, and the nature of the conspiracy is then investigated. Using experimental data, all Regge-pole conspiracy schemes involving the pion and at most one other conspiring family can be ruled out, under the assumption of constant residue functions. An extremely simple semiphenomenological formula that agrees with experiments is then proposed. The formula is consistent with a model which includes π exchange and conspiracies of branch cuts in the angular momentum plane. It is suggested that the relevant branch cuts are those arising from ρ-P and A_2-P exchange, where P is the vacuum trajectory. (auth)

11689 NONRELATIVISTIC SUM RULES AND THE BINDING ENERGY OF THE DEUTERON. Chadan, K.; Montes Lozano, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev., 164: 1762-6(Dec. 25, 1967).

Nonrelativistic sum rules obtained in potential scattering with potentials of finite radius are used to calculate in a very simple way the deuteron binding energy from the neutron-proton triplet-S phase shift. In order to use these sum rules, one must know the imaginary zeros in the k plane ($k = \sqrt{E}$) of the regular solution $\varphi(k,r)$ of the radial Schroedinger equation. These are studied in detail for an arbitrary potential (whether having a finite radius or not), and their properties are established. It is found that these zeros are closely related to the bound states. In particular, their number is the same as the number of bound states. If we denote the zeros by $i\gamma_j(r)$, $j = 1 \ldots n$, it is shown that each $\gamma_j(r)$ is an increasing function of r and has a finite limit for $r \rightarrow \infty$, which corresponds to a bound state of energy $E_j = -\gamma_j^2(\infty)$. These facts, together with the sum rules, enable us to calculate the bound-state energies in a very simple and direct manner from the phase shift and the interaction radius, which is an arbitrary parameter in the sum rules and may be chosen as large as necessary in order to be sure that one is really outside the range of the interaction. The method is applied to the deuteron, assuming that the n-p interaction in the $^3S_1$ state has a radius of the order of the triplet scattering length (a_t = 5.4 F), i.e., more than 3 times the triplet effective range (r_{0_t} = 1.73 F). The result is 2.30 MeV, in good agreement with the experimental value 2.224 MeV. This particular example shows that although, in general, the phase shift and the binding energies are (except for the Levinson theorem) independent of each other, it may be possible, for interactions of short range, to calculate the latter from the former in a simple way by making the physically reasonable assumption that the interaction vanishes identically beyond some radius, which may be taken as large as necessary. Some possible applications of the sum rules are briefly indicated at the end. (auth)

11690 SYNCHROTRON-RADIATION MODEL FOR MESON PRODUCTION IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Arnold, Richard C. (Argonne National Lab., Ill.); Heckman, Philip E. Phys. Rev., 164: 1822-8(Dec. 25, 1967).

A semiclassical model for emission of bosons in high-energy hadron collisions is proposed, based on an analogy with electromagnetic radiation from a radially accelerated moving charge. A simple assumption concerning the shape of the effective classical trajectories leads to absolute predictions with no free parameters for reactions such as $pp \rightarrow pp\pi^0$ and $pp \rightarrow pn\pi^+$. These predictions are in good agreement with available experimental data in the region of validity of the model, which is confined to relatively large momentum transfers. (auth)

11691 SIMULTANEOUS np AND pp PHASE SHIFT ANALYSIS AT 18.2 AND 9.9 MeV AND THE QUESTION OF ADDITIVITY OF COULOMB AND NUCLEAR PHASE SHIFT. Janout, Z.; Kazarinov, Yu. M.; Lehar, F.; Ulehla, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., 18: 18-23 (1968).

The simultaneous phase-shift analysis of np and pp data is performed at 18.2 and 9.7 MeV. Three and four sets of phase-shifts are obtained, respectively. The previously obtained nuclear potentials for non-mixing states of the two-nucleon system are used to calculate the maximum error in the simultaneous phase-shift analysis, due to the assumption on the additivity of the Coulomb and nuclear phase-shifts. Optimal experiments are planned for a further specification of the experimental quantities. (auth)

11692 POLARIZATION CORRELATION IN THE SCATTERING OF POLARIZED NUCLEONS. Janout, Z.; Lehar, F.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., 18: 8-17(1968).

Experiments concerning the spin correlation tensor C_{pqik} in the scattering of polarized nucleons on polarized nucleons are discussed. Relativistic formulas are derived for the experimental quantities. The scattering matrix is directly reconstructed with the help of experimentally measured quantities. The components of C_{pqik} are predicted for n-p scattering at 630 MeV and are given on graphs. (auth)

11693 EXISTENCE AND PRODUCTION OF A POSSIBLE BOUND CASCADE-NUCLEON SYSTEM. Goble, Robert Lloyd. Madison, Wis., Univ. of Wisconsin, 1967. 69p.

Thesis.

The strength of the interaction between two baryons resulting from the exchange of pseudoscalar mesons is estimated by considering the longest range contribution of certain dispersion integrals. It is shown that, with the presently accepted values for meson couplings, some states with strangeness minus two have interactions comparable in magnitude to the bound state of zero strangeness, the deuteron. These results suggest that it would be of interest to look for two-baryon bound states with strangeness minus two; however, no definite prediction of their existence can be made since other forces must play an important role in the binding. A prediction is made of the cross section for producing one such possible state, a bound Ξ^- neutron, in K^--deuteron scattering. The calculation assumes that the anomalous threshold of the triangle diagram is the dominant singularity, and uses the experimental Ξ^- production amplitude. At incident K^- momenta of 1.3 and 2.0 BeV/c, the cross sections are computed to be 30 and 6 μb. The former value is a maximum in the cross section caused by the maximum in the cascade production amplitude. It is shown that the calculation is not materially modified if the Ξ^--n is not bound, but forms a low-lying resonance. (Disser. Abstr.)

11694 ONE-MESON-EXCHANGE POTENTIALS AND PROPERTIES OF NUCLEON–NUCLEON SCATTERING AND OF NUCLEAR MATTER. Ingber, Lester. San Diego, Calif., Univ. of California, 1967. 91p.

Thesis.

The problem this thesis undertakes is to define an interaction between nucleons to be used to consistently calculate: Nucleon-nucleon elastic scattering processes reproducing experimental scattering data (phase shift analyses). The binding energy and equilibrium density of a "large" system of nucleons (nuclear matter). The nature of these two problems requires that this interaction: Be applicable throughout a laboratory incident energy range of about 0–400 MeV [below inelastic thresholds], be defined with minimum phenomenology —i.e., to use as much theoretic guidance as possible to define a unique interaction. This last requirement actually prompted this work as phase-shift analyses of nucleon-nucleon scattering seem to be relatively insensitive to various functional forms of potentials, compared to the more sensitive nuclear matter calculations using the same potentials. Since the last major hurdle to understanding of nuclear matter appeared to be the inability to define such a potential, this work

was undertaken after an enlightening seminar given by David Wong on the use of a one-meson exchange model to rather successfully calculate nucleon-nucleon scattering processes using dispersion-relation theory. David Wong also suggested a method for deriving a potential to be used in Schroedinger's theory, which is necessary to solve the nuclear matter problem. The total Lagrangian describing nucleons and their interaction via one-meson exchanges was nonrelativistically reduced, corresponding to a Schroedinger equation with a velocity-dependent (not energy-dependent) potential of the form described by Scotti-Wong (modified to interpret cutoffs and momentum dependence). To preserve the correct eigenvalue properties of the integral-equation formulation of the two-body Schroedinger's equation, it was found necessary to keep the potential of operator form (i.e., containing differential operators), and not merely a function of the radial parameter. However, integration by parts allows one to operate on the Green's function instead of on the wave-function. As the Green's function is expressed in simple analytic (differentiable) functions, the resulting integral-equation is really no harder to solve than one involving a simple potential function. Keeping the potential in this operator form also allows one to correctly project the potential from a set of five invariant helicity amplitudes onto the more common, though phenomenological, set of five invariant Wigner forms which are eigen-operators of the partial-wave reduced wave-functions, in turn expressed as eigenfunctions of the total angular momentum. Then this potential, so "uniquely" defined, and giving analytic functions throughout coordinate space, is similarly defined to perform a modified nuclear matter calculation similar to that done by Brueckner and Masterson. When compared with other current potentials, this potential, with only 8 parameters (themselves reasonable physical quantities), proves itself to be the best overall description of the nucleon-nucleon interaction, after doing detailed calculations of nucleon-nucleon scattering, the deuteron state, and nuclear matter. (Disser. Abstr.)

Particle Invariance Principles and Symmetries

General

11695 ALGEBRA ASSOCIATED WITH THE VECTOR AND AXIAL-VECTOR CURRENT. Radicati, L. A. (Scuola Normale Superiore, Pisa, Italy). pp 294-329 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

Following an introductory section on the use of sum rules in atomic and nuclear physics, the SU(3) algebra associated with the time component of the vector current is discussed. The U(6) × U(6) algebra generated by the vector and axial-vector currents and the sum rule for the axial-vector current obtained from one of its subalgebras are then introduced. Some of the consequences which follow from the commutation relations of charges and currents and from those of two currents are discussed. Finally, a brief outline is given of the general methods used to discuss the consequences of local commutation relations proposed by Fubini and by Gell-Mann and Dashen. (L.B.S.)

11696 CLASSIFICATION OF PARTICLE MULTIPLETS. Zumino, Bruno; Zwanziger, Daniel (New York Univ.). Phys. Rev., 164: 1959-81(Dec. 25, 1967).

It is observed that in considering how particle states transform under Θ = CPT one cannot neglect internal symmetries, since Θ changes the signs of all conserved internal additive quantum numbers; and that, furthermore, if a physical theory admits a parity symmetry P, this symmetry may also, like Θ, effect an automorphism on the group of internal symmetries, as does, for example, CP, the correct parity operator in the presence of weak interactions. All types of particle multiplets are found for massive particles that are compatible with local field theory, particle multiplets being defined as the irreducible corepresentations of the group obtained by extending the internal symmetry group by P and Θ. Of the thirteen types that exist, only three occur in the various approximation schemes that are at present used to describe nature. The reason for the nonappearance of the other types is not to be found in the usual postulates of local field theory, because Lagrangian field-theoretical examples of all thirteen types do exist and are given. (auth)

11697 CONNECTION BETWEEN SU(3) AND O(4). Ravenhall, D. G.; Sharp, R. T.; Pardee, W. J. (Univ. of Illinois, Urbana). Contract 00014-67-A-0305-0005. Phys. Rev., 164: 1950-5 (Dec. 25, 1967).

It is shown that the insertion of a barrier, in the isotropic harmonic oscillator and in the hydrogen atom, gives each system the higher symmetry usually associated with the other. The result is more general: The imposition of a reflection condition can change SU(3) to O(4), and vice versa. This may have implications for elementary-particle symmetries. (auth)

11698 CONCEPT OF EXACT GROUP SYMMETRY AT INFINITE FOUR-MOMENTUM AND GENERALIZED HAAG'S THEOREM. Acharya, R. (American Univ., Beirut, International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 164: 1799(Dec. 25, 1967).

Within the framework of a relativistic field theory satisfying the Wightman axions, it is demonstrated that an asymptotically exact internal group symmetry is, in fact, exact (i.e., for all q^2), provided one employs the usual, nonstrange representations of the canonical commutation relations. (auth)

11699 ALGEBRA OF SPIN CURRENTS AND THE RELATIVISTIC FORMULATION OF SU(6). Bitar, Khalil M.; Gursey, Feza (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., 164: 1805-19(Dec. 25, 1967). (YALE-2726-505).

The infinite algebra of covariant spin current densities is studied. It is generated by local second-rank tensor operators odd under charge conjugation C, and involves tensors of higher rank that can be C even or C odd. Explicit constructions are given for S = ½, 0, and 1. The spin algebra is assumed to be valid for fields with nonderivative interaction. The algebra is generalized when an internal symmetry group like SU(3) is present. It is then shown that on one-particle states the algebra closes, giving an SU(6) ⊗ SU(6) symmetry group, magnetic-moment operators being among the generators. When two-particle states are considered, the algebra involves C-even longitudinal (with respect to the relative momentum) and C-odd transverse spin operators that close, giving an $SU_W(6)$ algebra which remains valid when restricted to the matrix elements of the spin algebra between two one-particle states. Saturation of this algebra by the (56,1) representation of the one-particle symmetry group gives nonzero anomalous magnetic moments and the same ratio $D/F = -\mu_p/\mu_n = \frac{3}{2}$ as in the nonrelativistic SU(6) group. (auth)

11700 GROUP THEORY IN PARTICLE STUDIES. Tuan, San Fu. Phys. Today, 21: 31-41(Jan. 1968).

The meaning to be ascribed to compact group, noncompact group and such terms as unitary infinite-dimensional representation is discussed. A purely pedestrian understanding of compactness is given rather than its topological implications. The continuous Lie groups considered have group elements that depend analytically on the parameters characteristic of the group. The algebra of current components, commutation rules, the hydrogen atom model, hadron mass spectra, quark theory, and resonances are covered. (J.F.P.)

11701 QUANTUM AND CLASSICAL NON-LOCAL EFFECTS AND INTERNAL SPACE DYNAMICS. Wisnivesky, Daniel. New York, Yeshiva Univ., 1967. 99p.

Thesis.

The properties of the nonlocal effects of potentials are discussed. The Aharonov-Bohm effect is generalized to all gauge theories and it is shown that, contrary to the usual point of view, the effect is not necessarily quantum mechanical in nature. Examples of classical theories are given in which the same kind of effects are present and it is shown that there is no intrinsic distinction between the classical and quantum effects of potentials. It is also shown that it is possible to formulate a theory in terms of local gauge invariant quantities where nevertheless the same effects exist. In these theories the effect cannot be attributed to any special property of the potentials and instead can be looked upon as due to the fact that for certain initial conditions the solutions of the equations of motion develop instabilities. A model of internal space of elementary particles is discussed. In this model the internal space is topologically equivalent to the group space of symmetries which is assumed to be valid in a certain dynamical limit. The properties of elementary particles are related to the interactions of the fields of the particles and the geometry of internal space. A simple example is worked out, and it is shown how the dynamics of the internal space breaks the symmetry and induces a mass spectrum of the particles. Finally some comments are made with special reference to the SU_3 group of symmetries. (Disser. Abstr.)

Applications (Electromagnetic and Weak)

11702 SYMMETRIES OF THE WEAK INTERACTIONS. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). pp 248-93 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

The topics discussed include: the TCP theorem; superselection

rules; space-time symmetries; K^0 and η decays; internal symmetries; SU(3) transformation properties; nonleptonic decays; and algebra of vector and axial-vector charges. (L.B.S.)

11703 WEAK INTERACTIONS AND UNITARY SYMMETRY. **d'Espagnat, B. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). pp 69-115 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.**

Generalities on weak interactions and groups are presented. An analysis of leptonic decays based on the application of SU(3) symmetry to the weak current of the strongly interacting particles is discussed. Experimental mass differences are taken into account in a phenomenological way at a few stages in the calculation of matrix elements for K_{l3}, π_{l3}, and hyperon leptonic decays. An attempt then is made to relate the nonleptonic weak interaction properties to symmetry group properties of the strong interaction by extrapolation of the ideas on leptonic decays. A note is given on the tadpole theory of weak interactions. The final section deals with intermediate bosons and unitary symmetry. (L.B.S.)

11704 MAGNETIC MOMENTS, FORM FACTORS, AND MASS SPECTRUM OF BARYONS. **Barut, A. O.; Corrigan, Dennis; Kleinert, H. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 20: 167-71(Jan. 22, 1968).**

The following baryon properties are derived and correlated in a relativistic theory based on the dynamic group $O(4,2) \sim SU(2,2)$: absolute values of the magnetic moments, form factors $G_M(t)$ and $G_E(t)$, mass spectrum, and decay rates. Some new predictions are made. (L.B.S.)

11705 POLE MODEL APPROACH TO WEAK INTERACTIONS IN SU(3) AND SU(6). **Graham, Robert Hall. Lafayette, Ind., Purdue Univ., 1967. 99p.**

Thesis.

The nonleptonic and weak-electromagnetic decays of baryons are studied in the context of the SU(3) and SU(6) symmetry schemes. The dynamical basis for these decays is assumed to consist of various pole models. From SU(3) symmetry considerations alone sum rules are obtained among the amplitudes for both the nonleptonic and weak-electromagnetic baryon decays. The $\Delta T = \frac{1}{2}$ rule and the Lee–Sugawara relation are obtained in special cases. An SU(3) pole model is set up for the baryon nonleptonic decays and the parameters appearing in it are calculated by fitting the resulting amplitudes to experiment. These parameters are then used in an SU(3) pole model for the weak-electromagnetic baryon decays to predict their rates. The rate predicted for the decay $\Sigma^+ \to p + \gamma$ is close to the recent experimental result. The rate of the decay $K_2^0 \to \gamma + \gamma$ and the $K_1^0 - K_2^0$ mass difference are also calculated, but are found to be considerably larger than experiment. The baryon nonleptonic decays are studied in an SU(6) pole model. Sum rules for the amplitudes are obtained and compared with experiment. Finally, a theorem concerning the parity-conserving amplitudes of the baryon nonleptonic decays, due to B. W. Lee, is extended to more general situations. A pole model, based on the general Cabibbo current-current theory and equal spacing for the baryon masses (Λ and Σ degenerate), is found to be equivalent to an effective interaction which does not arise directly from the Cabibbo hypotheses. Motivated by recent work of Suzuki and Sugawara we assume that the parity-conserving amplitudes derive from a pole model, but that the parity-violating amplitudes do not. As a result, it is found that both the parity-conserving and parity-violating amplitudes arising from the Cabibbo theory satisfy two identical sum rules. One sum rule relates the $\Delta T = \frac{3}{2}$ amplitudes of the Λ and Ξ decays and the other has the form of a general Lee–Sugawara relation. It is also shown that both the original Lee theorem and its extension can be generalized to include more realistic assumptions about the baryon masses. (Disser. Abstr.)

11706 CURRENTS AND CURRENT COMMUTATORS: AN APPLICATION TO SCATTERING PROCESSES AND NON-LEPTONIC DECAYS. **Gundzik, Michael George. Syracuse, N. Y., Syracuse Univ., 1966. 191p.**

Thesis.

A method for calculating the S-matrix elements of a number of physical processes is developed and applied to the nonleptonic decays of hyperons as well as baryon-meson and meson-meson scattering. The S-matrix element in question is extrapolated to an off-mass-shell point and simplified by the use of the partially conserved axial vector current hypothesis and an algebra of the weak vector and axial vector currents under equal time commutation based on the quark model. The conditions necessary for the extrapolation of the off-mass-shell results back to the mass shell are clarified. The properties of the weak currents are studied and the necessity for the presence of Schwinger terms is noted. The ambiguities of the off-mass-shell extrapolation which appears under similar circumstances in the derivation of the Goldberger–Treiman and Adler–Weisberger relations are discussed. In the application to hyperon nonleptonic decays the parity violating and parity conserving parts of the amplitude are studied in the framework of the group $SU(6)_W$. The decay amplitude which is described in terms of the usual weak Hamiltonian bilinear in Cabibbo currents is evaluated at an arbitrary point off the mass shell of the meson assuming the quark model for the currents and a single particle pole approximation. The nine S-wave and twelve P-wave decays of the baryons in the 56 dimension representation of $SU(6)_W$ are found to be determined by four parameters, one of which relates the S and P-wave decays. A new P-wave sum rule for the baryon octet decays $8\sqrt{3}P(\Xi^-) = 3P(\Sigma_0^+) + 3\sqrt{3}P(\Lambda^0) - (5/\sqrt{2})P(\Sigma_1^+)$ is found as well as new sum rules relating the Ω^- decay to the decays of the baryon octet. The method of off-mass-shell extrapolation used in the nonleptonic decays is extended first to the case of forward meson-baryon and meson-meson scattering for the calculation of the S-wave scattering lengths for the πN, KN, and $K\pi$ systems. Then this is generalized to the case of nonforward elastic scattering for the calculation of the S and P-wave low energy parameters and applied to the πN and KN systems. For the nonforward case, a partial wave analysis is performed on the off-mass-shell extrapolation of the scattering amplitude and the partial wave amplitude is expanded in a power series in two complex variables, one of which is q the common mass of the intital and final off-mass-shell mesons. The conditions for the convergence of this expansion are examined and the order of the continuum contributions to the off-mass-shell amplitude are determined. The low energy πN scattering parameters are calculated under the assumptions that the full amplitude is regular for $|q| \leq m_\pi$, fixed s, t and u, the contribution of the u-channel πN cut is negligible and that the off-mass-shell amplitude is gently varying in q. One finds reasonably good agreement with experimental values; the calculated scattering lengths lie within the limits of error of the experimental numbers. The low energy S and P-wave parameters for KN scattering are also calculated in this way with good results. Finally the extension of this analysis to photopion production is indicated. Here one finds that the off-mass-shell extrapolation is gauge invariant for the isoscalar but not the isovector amplitude. (Disser. Abstr.)

Applications (Strong)

11707 BREAKING CHIRAL SYMMETRY. **Glashow, S. L. (Harvard Univ., Cambridge, Mass.); Weinberg, Steven. Contract AT(30-1)-2098. Phys. Rev. Lett., 20: 224-7(Jan. 29, 1968).**

Chiral-symmetry breaking is explored under two assumptions: (1) the Lagrangian is invariant under $SU(3) \times SU(3)$ except for a term which transforms under the representation $(\underline{3},\underline{3}^*) + (\underline{3}^*,\underline{3})$, and (2) certain vertex functions are as smooth as possible. No assumption is made concerning the magnitude of the symmetry-breaking term. The natural appearance of a pseudoscalar nonet π, K, η, and η^*, and of a scalar kaon κ lying below or just above the $K\pi$ threshold is found. In addition, a refinement of the Ademollo-Gatto theorem for the K_{e3} form factor $f^+(0)$ is obtained. (L.B.S.)

11708 NONFORWARD SUPERCONVERGENCE RELATIONS, HIGHER SYMMETRIES, AND MASS SPECTRA. **Freund, Peter G. O.; Oehme, Reinhard; Rotelli, Pietro (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 164: 1859-64(Dec. 25, 1967). (COO-264-392).**

Superconvergence relations for the reactions PV → PV, PV → VV, and VV → VV between nonets of pseudoscalar and vector mesons can be saturated at zero momentum transfer with sets of particles corresponding to the representations $(6,\bar{6};l)$ of the rest-symmetry group $U(6) \times U(6) \times O(3)$. Every single one of these representations saturates the relations, provided the vertices are invariant under the collinear $U(6) \times O(2)$ group. The infinite sequence of representations $(6,\bar{6};l)$, $l = 0,1, \ldots$ is then used in order to saturate the nonforward superconvergence relations for the reactions PV → PV. For mass spectra m_l with accumulation points $m_\infty^2 > 4m_1^2$, it is found that the resulting equations have no nontrivial solution for the coupling constants. This result remains unchanged for an oscillator-like spectrum. The possibility is discussed that mass splitting within the multiplets $(6,\bar{6};l)$ and/or symmetry breaking at the vertices can in principle make a saturation possible. It is argued that an approximate saturation of the amplitudes and a few of their derivatives at $t = 0$ with a finite number of resonances may well be reasonable. For higher derivatives the saturation is expected to depend sensitively upon the absorptive parts at higher energies, which are more reasonably described by Regge terms than by direct-channel resonances. The formal saturation of superconvergence relations with mass-degenerate multiplets is discussed briefly. (auth)

11709 MASS-SPLITTING THEOREM FOR TRANSLATIONALLY INVARIANT NONINTEGRABLE LIE ALGEBRAS. O'Raifeartaigh, L. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 164: 2000-2(Dec. 25, 1967). (NYO-3399-121; SU-1206-121).

A rigorous theorem prohibiting the derivation of stable baryon mass spectra from unitary representations of Lie groups was previously generalized to the case of nonunitary group representations. The generalization is taken a stage further; namely, it is shown that, subject to some physically mild conditions concerning translational invariance and closure, an analogous theorem can be established for the case of nonintegrable representations of Lie algebras. (auth)

11710 THEORY OF SELF-INDUCED STRONG INTERACTIONS. Susskind, Leonard (Yeshiva Univ., New York); Frye, Graham. Phys. Rev., 164: 2003-56(Dec. 25, 1967).

A theory of strong interactions, based on the idea that each hadron is a composite of other similar hadrons, is constructed. The necessary concepts of composite-particle structure are defined in terms of linear relations between the vectors describing single-particle states and certain multiparticle vectors which are not energy eigenstates. The theory is not an S-matrix theory, but rather, it directly represents the instantaneous interactions and time development of a system of particles in terms of the interactions of the objects which make up the particles, namely, other similar particles. The Hamiltonian is constructed so as to propagate particles freely when they are far apart, and to provide the necessary binding forces to bind the composites when the particles are close. These same forces are, of course, responsible for the scattering and particle reactions which occur for colliding particles. All of this is done without the use of the local-field concept. The particle states used as a basis in the space of states describe fully clothed, "real" structures. (auth)

11711 DISPERSIVE CALCULATION OF SYMMETRY BREAKING CORRECTIONS TO STRONG COUPLING CONSTANTS. Kwiecinski, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 32: 855-9(Nov. 1967).

The dispersive method is proposed for calculating the symmetry breaking corrections to strong coupling constants. The method is based on the dispersive representation of the suitably chosen matrix elements of current divergences. Approximation of these matrix elements in the limit of vanishing four-momentum connected with currents by near-by poles leads to group theory results for strong coupling constants. Corrections come from distant singularities and are presented in the form of dispersive sum rules. The method is illustrated on an example of BBP couplings in broken SU(3) symmetry. (auth)

11712 VECTOR MESON PRODUCTION AND $[SU(3) \otimes SU(3)]_{coll}$ SYMMETRY. Winternitz, P.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., 18: 1-7(1968).

The collinear production of a vector meson is considered in the scattering of pseudoscalar mesons on baryons. Relations between the experimental quantities, following from the symmetry $[SU(3) \otimes SU(3)]_{coll}$, are obtained. (auth)

Field Theories

General

Refer also to abstract 11576.

11713 REFORMULATION OF CLASSICAL ELECTRODYNAMICS. Henin, F. (Univ., Brussels). pp 41-67 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The difficulties of the usual classical theory of electrodynamics are briefly reviewed. The possibility of introducing a structure of the particle in a covariant manner is considered. The case of the electromagnetic quantities produced by an extended charge at rest, in uniform motion, and in arbitrary motion is treated. The theory is entirely phenomenological and is based on a single form factor. A possible equation of motion is considered, which is discussed in the case of one-dimensional motion. (L.B.S.)

11714 ELEMENTS AND FORMULAE OF SPECIAL RELATIVITY. Guggenheim, E. A. New York, Pergamon Press, Inc., 1967. 71p. $2.50 Flexi-Cover, $4.00 Hard-Cover.

The discussion of special relativity includes kinematics, light propagation, the mechanics of single bodies, general mechanics, hydrodynamics, thermodynamics, four-vectors, and vector operators. Also discussed are the electromagnetic field, electrodynamics, and statistical mechanics. A historical synopsis is given. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 11568, 11603, and 11625.

11715 PRECISION TESTS OF QUANTUM ELECTRODYNAMICS AT LOW ENERGIES. Drell, S. D. (Stanford Univ., Calif.). pp 199-247 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

A very precise hyperfine structure measurement in hydrogen and precise g-2 measurements of the electron and muon are reviewed and analyzed. The proton structure corrections which go into the theoretical hyperfine splitting (hfs) value is critically examined in order to account for the apparent discrepancy between experiment. The theoretical expression for the hfs and the corrections to it are first reviewed with emphasis on the proton polarizability contribution. Two nonrelativistic models of the proton structure are then constructed and their contributions are calculated. Their relation to a recent quark model calculation and to the original analysis of Bohr for the polarizability effect in the hfs analysis of deuterium is also discussed. The relativistic calculation of the proton structure is discussed, and finally the problems of subtraction constants and contributions from high energy are taken up. Calculations of QED and non-QED contributions to the g-2 value of muons to the third order of in the fine structure constant are carried out in the second part. 69 references. (L.B.S.)

11716 INTRODUCTION TO SOME ASPECTS OF THE RELATIVISTIC DYNAMICS OF QUANTIZED FIELDS. Wightman, A. S. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). pp 171-291 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

A review is given in part I of all known explicitly soluble relativistic models in quantum field theory. The following topics are included: generalized free fields and their equivalence classes; theory of Lie fields; models in two-dimensional space-time; and general methods for constructing new theories from old. Part II gives an assessment of the interaction picture method for obtaining solutions of the standard nontrivial models. Haag's theorem, the ultraviolet catastrophe, Hilbert space technique, vacuum stability, and models of existence theorems are included. (L.B.S.)

11717 SELECT FRAGMENTS OF DISTRIBUTION THEORY LAPLACE TRANSFORMATION AND KLEIN-GORDON EQUATION. Zerner, M. (Univ., Nice). pp 293-323 of High Energy Electromagnetic Interactions and Field Theory. Levy, Maurice (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967. (In French).

Two theoretical results found useful in Wightman field theory are presented. One gives as precise a description as possible for the Laplace transformation of a tempered distribution which is annulled outside the future cone (or other aggregates of the same type). The other is a property of partial regularity of the solutions of the Klein–Gordon equation which allows one to speak of the value of an instant given a distribution solution of this equation (and derivatives of the solution). Fundamental ideas on the Fourier transformation for distributions, and a proof of results on the structure of the distributions from which the Laplace transform and the Klein–Gordon equation are obtained as well are given. (J.F.P.)

11718 NEW FORMALISM FOR THE QUANTIZATION OF A SPIN-$\frac{3}{2}$ FIELD. Munczek, Herman (Northwestern Univ., Evanston, Ill.). Phys. Rev., 164: 1794-8(Dec. 25, 1967).

The general equation satisfied by a vector-spinor field is considered and it is found that in addition to the spin-$\frac{3}{2}$ solution there are two spin-$\frac{1}{2}$ solutions of arbitrary masses. The conditions for these masses to be infinite and identical to the irreducibility conditions of the Rarita–Schwinger formalism. It is shown that a consistent quantization can be achieved, and some of the usual difficulties avoided, if the limit of infinite masses is taken after the quantization. This is similar to what happens in Lee and Yang's ξ-limiting formalism for vector bosons. It is also found that the spin-$\frac{1}{2}$ part acts as a regulator for the propagator of the field. (auth)

11719 EQUIVALENT FIELD THEORIES AND BOUND STATES. Zimmerman, Robert L. (Univ. of Oregon, Eugene). Phys. Rev., 164: 1945-50(Dec. 25, 1967).

It was previously shown how one can eliminate an arbitrary number of fields from a general Lagrangian and obtain a new one. Regardless of which Lagrangian was used to evaluate the matrix elements for the elementary fields, equivalent results were obtained. It is the principal object of this paper to investigate the matrix elements of the so-called redundant fields, i.e., the fields that do not explicitly appear in the Lagrangian. Complete agree-

ment among all matrix elements calculated with either of the Lagrangians is achieved only in the limit that the Lagrangian becomes local. It is also shown how one can construct an expression for the redundant fields in terms of the elementary fields. In the limit that $Z_3 \to 0$, this expression for the redundant fields agrees with those discussed by Nishijima, Zimmermann, and Haag. (auth)

11720 THE σ-MODEL OF GELL-MANN AND LEVY FOR A PARTIALLY CONSERVED AXIAL VECTOR CURRENT. Khan, I. (Univ. of Edinburgh). Nuovo Cim. (10), 53A: 18-23(Jan. 1, 1968).

An interpretation of the ill-defined bilinears of Fermi field occurring in the model is given which rids it of the undesirable feature, recently pointed out, of the presence of zero-mass particles. (auth)

11721 YANG-MILLS THEORY AND CURRENT ALGEBRA. Costa, G.; Savoy, C. A.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim. (10), 53A: 48-55 (Jan. 1, 1968).

It is shown that the soft-meson results, obtained from current algebra and meson pole dominance in the matrix elements of the vector current and the axial and tensor current divergences, are equivalent to those obtained from an effective Yang-Mills Lagrangian. (auth)

11722 ZERO-DIMENSIONAL PHYSICS, STAIRS, CONTINUED FRACTIONS, AND CONVERGENCE PROBLEMS. Jouvet, B. (College de France, Paris); Tirapegui, E. Nuovo Cim. (10), 53A: 69-106(Jan. 1, 1968).

A large class of quantum-field-theory models is studied in a universe with no space dimension and one time dimension. Continued-fraction expansions are found for the different matrix elements of the models and the convergence problems of the theories are discussed in detail. (auth)

11723 NONEXISTENCE OF CLASSES OF YANG-MILLS FIELDS. Loos, H. G. (Douglas Advanced Research Labs., Huntington Beach, Calif. Univ. of California, Riverside). Nuovo Cim. (10), 53A: 201-12(Jan. 1, 1968).

Nonexistence is shown for regular localized free classical Yang-Mills fields with nonvanishing $\varphi_{\kappa\alpha}$, with a semi-simple and compact internal holonomy group, and with one of the following types of time dependence: (1) there exists a gauge in which the potentials are independent of time, (2) the gauge field $\varphi_{\kappa\lambda}$ is covariant constant in time, (3) there exists an internal operator field $T(x^\kappa)$ such that $\nabla_t \varphi_{\kappa\lambda} = [T, \varphi_{\kappa\lambda}]$ where $\nabla_\kappa T$ belongs to the Lie algebra of the holonomy group, and the matrix formed from the adjoint representation of the gauge field and its dual has maximal rank. (auth)

11724 RELATIVE TIME AND BETHE-SALPETER SOLUTIONS. Bui-Duy, Q. (Univ., Rome). Nuovo Cim. (10), 53A: 292-7(Jan. 1, 1968).

The physical meaning of the Bethe-Salpeter amplitudes and the role of the relative time in the Bethe-Salpeter equation are investigated. The consideration is limited to physical systems whose kinematical freedom is the time coordinate. Together with time translational invariance, the Bethe-Salpeter amplitude depends only on $t = t_1 - t_2$ which is assumed to be positive. An exactly solvable model is considered. Not only energy eigenvalues are known, but also energy eigenstates are found explicitly in terms of free states. A system of fermions is considered. (J.F.P.)

11725 DOMAIN OF THE TIME-AVERAGED FIELD OPERATOR IN AXIOMATIC FIELD THEORY. Kolm, A. (Royal Inst. of Tech., Stockholm). Nuovo Cim. (10), 53A: 298-300(Jan. 1, 1968).

The time-averaged field operator in a quantum field theory as formulated by Wightman is studied. The field is assumed to be an operator-valued tempered distribution and $\phi(x_0)$ belongs to the test function space. Restriction is made to the case of one single neutral scalar field. It is shown that this time-averaged operator actually is well-defined on the standard set D and that it maps D into itself. D, which is dense in the Hilbert space, is generated by the polynomial algebra in the field smeared out in all its variables. Especially it follows that D contains the dense set D_0. (J.F.P.)

11726 THEORY OF FREE RELATIVISTIC MULTIPOLE FIELD. II. QUANTUM PART. Lukierski, J. (Wroclaw Univ.). Acta Phys. Pol., 32: 771-99(Nov. 1967).

The quantized multipole field Φ_n of n-th order is described by a set of n three-dimensional operator-valued distributions $C_j(\vec{p})$, satisfying the commutation relations $[C_i^+(\vec{p}), C_j(\vec{p}')] = \epsilon_i \delta_{ij} \delta(\vec{p} - \vec{p}')$, where i, j = 0, 1, ..., n − 1 and $\epsilon_i = \pm 1$. The particle states, created by the operators $C_i(\vec{p})$ have definite three-momentum, but not definite energy. Unique combinations $a_n^{as}(\vec{p})$ of the operators $C_i(\vec{p})$, describing the particle also with definite energy are introduced. It is shown that only these particles, with definite value of the four-momentum and described by zero norm states, appear in the asymptotic limit. One can conclude therefore that the asymptotic space consists of null vectors, and all S-matrix elements between asymptotic states vanish. (auth)

11727 AXIOMATIC MODEL OF QUANTUM FIELD THEORY. Slavnov, D. A. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 53: 1641-9(Nov. 1967). (In Russian).

A variant of the axiomatic method in quantum field theory previously proposed is considered. Equations for the Heisenberg field operators are set up in accordance with the method. Solutions of the equations are derived. It is elucidated when the model possesses only trivial solutions. (auth)

11728 ON SPINNING PARTICLES. Sutton, Albert Murad. New York, Yeshiva Univ., 1967. 41p.

Thesis.

There exist classical systems whose canonical quantization yields relativistic wave equations. As a constructive proof, the classical mechanics of a translating-rotating five-frame is considered. Its quantization yields the Dirac, Weyl, Klein-Gordon, Maxwell-Proca, and higher spin equations, together with a rotational mass spectrum for the states predicted. The motion of the free classical particle is studied, its anomalous behavior shedding light on the general breakdown of the probability interpretation of relativistic wave equations. Interactions are next discussed. Electromagnetic interactions, in Maxwell field and Fokker action-at-a-distance formulations, yield a theory that is the classical analog of quantum electrodynamics. Point-contact interactions between particles are contemplated, and it is shown that, at the classical level, it is impossible to formulate these in a Lorentz-invariant way. In addition, it is found that many-body systems are subject to constraint ideals, constituting irreducible modules under the action of the symmetric group. These features suggest that a correct quantum treatment of interactions may encounter unanticipated complexity. The conjectured interpretation of the theory, and its connection with gravitation, are briefly discussed. The discussion concludes with a mathematical principle relating ordinary differential equations to families of linear partial differential equations, and this is further illustrated in the case of the Cauchy-Riemann equations of analytic function theory. (Disser. Abstr.)

11729 CURRENT FORMALISM IN ASYMPTOTIC QUANTUM FIELD THEORY. Wray, James Glendenning Jr. Syracuse, N. Y., Syracuse Univ., 1967. 142p.

Thesis.

A finite formulation of quantum field theory is developed with the following results. It is free of divergent expressions and of cut-offs. Only physically defined parameters enter the theory such that there is no renormalization. For the renormalizable theories a unique solution is specified in perturbation expansion. For the nonrenormalizable theories it is demonstrated that a finite unique solution exists in perturbation expansion to any prescribed order but this is possible only at the expense of introducing a number of parameters that increases with the order of perturbation. In addition, the analogs of the interacting field and S_{op} representations as R and Φ-products of fields, respectively, are derived in a current representation. The basic assumptions of the theory are unitarity and Bogoliubov causality as strong operator equations, completeness of the in (out) fields on a unique vacuum, the asymptotic condition, and invariance under the Poincare group. Equations of motion are replaced by integro-differential equations for m-point functions that are derived directly from the axioms with the aid of a "generalized step" or Π-function. The algebra of these Π-functions which are tempered distributions in the form of integral operators, is the main technical tool used. The Π-functions are similar to step functions only with a convolution law of combination that enables the formation of products with distributions. This is central to their success as the elemental unit of ordering for products of currents. One is forced to "Π"-order currents instead of fields since the products of Π operators and fields are not defined in general. Thus the current formalism arises naturally within the framework of asymptotic quantum field theory upon the identification of the Π-function algebra and the elimination of the field. This latter point, the absence of any interacting field, permits a direct generalization in the manner of Chen (C3,C4) to an S-matrix program for nonrenormalizable interactions. Again, the algebra of the $\Pi^{[N]}$-functions (for $\Pi^{[N]}$ a generalization of the Π-functions due to Chen (C3,C4)) is the main technical tool enabling this extension. A judicious application of the $\Pi(\Pi^{[N]})$-algebra permits a diagrammatic analysis of the equations in perturbation expansion for renormalizable (nonrenormalizable) interactions. This has not been possible so far, in the field representation, and explains in part the boundary condition difficulties of previous formulations (P1,C3) since the identification of diagrams proves to be a necessary step in the program. In the present work boundary con-

ditions are deduced for the φ^3 and φ^4 (L_{int}) interactions with a sample computation carried out in the former. (Disser. Abstr.)

Gravitation and General Relativity

Refer also to abstracts 11120 and 11192.

11730 ENERGY AND FRAMES OF REFERENCE IN GENERAL RELATIVITY. Graiff, Franca (Politecnico, Milan. Istituto di Matematica, Milan). Meccanica, 2: 69-74(June 1967).

Definition of the energy momentum density and superpotentials that give rise, in a privileged frame of reference, to the known integral results due to the Einstein and Freud pseudotensors. The snags due to their spontaneous laws of transformation are eliminated simply by substituting for them other objects that coincide with them in the privileged frame of reference but differ from them in their transformation laws. This method may be used even when hypotheses relating to the closed system are no longer satisfied—i.e., when the system is not closed but radiative. (IAA)

11731 GRAVITATIONAL SUPERENERGY AS A GENERATOR OF CANONICAL TRANSFORMATION. Komar, Arthur (Yeshiva Univ., New York). Phys. Rev., 164: 1595-9(Dec. 25, 1967).

The canonical transformation generated in linearized gravitation theory by the Robinson–Bel superenergy tensor is determined. The light this result sheds on the quantization program for the general theory of relativity is discussed. (auth)

11732 EVENT HORIZONS IN STATIC VACUUM SPACE-TIMES. Israel, Werner (Univ. of Alberta, Canada. Dublin Inst. for Advanced Studies). Phys. Rev., 164: 1776-9(Dec. 25, 1967).

The following theorem is established. Among all static, asymptotically flat vacuum space-times with closed simply connected equipotential surfaces g_{00} = constant, the Schwarzschild solution is the only one which has a nonsingular infinite-red-shift surface $g_{00} = 0$. Thus there exists no static asymmetric perturbation of the Schwarzschild manifold due to internal sources (e.g., a quadrupole moment) which will preserve a regular event horizon. Possible implications of this result for asymmetric gravitational collapse are briefly discussed. (auth)

11733 GRAVITATION FIELD IN THE UNIFORM QUANTUM FIELD THEORY. Treder, H.-J. (Forschungsgeminschaft, Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 9: 283-92(1967). (In German).

The principles of the rigorous theory are derived. The principles of a phenomenological theory of gravitation are given. (J.S.R.)

Scattering Theory

Refer also to abstract 11997.

11734 PROPERTIES OF SCATTERING AMPLITUDES AT HIGH ENERGY. Eden, R. J. (Cambridge Univ., Eng.). pp 1-62 of Particle Interactions at High Energies. Preist, T. W.; Vick, L. L. J. (eds.). New York, Plenum Press, 1967.

The types of experiments that are important to the study of high energy scattering are described briefly, and their main features are noted. The theoretical background and principle assumptions are reviewed. The general methods are described and are used to discuss upper bounds on cross sections and related quantities, lower bounds, and consequences of crossing symmetry. The special aspects of crossing symmetry related to the Pomeranchuk theorem are described. Special assumptions are added to obtain useful properties of partial wave amplitudes. Finally, the main methods and the consequent results on general properties of scattering amplitudes at high energy are summarized. (L.B.S.)

11735 EIGENPHASES AND THE GENERALIZED BREIT–WIGNER APPROXIMATION. Goebel, C. J.; McVoy, K. W. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 164: 1932-6(Dec. 25, 1967). (COO-881-113).

The relation between the repulsion of S-matrix eigenphases and "crossing" branch points (complex energies at which two or more eigenphases are equal) is examined in some detail. It is exploited to obtain a unitary one-pole approximation to the S matrix for the description of an isolated resonance superimposed on a non-elastic background. (auth)

11736 PARTIAL-WAVE ANALYSIS IN TERMS OF THE HOMOGENEOUS LORENTZ GROUP. Delbourgo, R.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 164: 1981-90(Dec. 25, 1967).

An attempt is made to generalize Toller's work on elastic forward scattering and to expand the general two-body amplitude for all values of momentum transfer in terms of unitary representations of SO(3,1). The covariant inclusion of spin is examined. (auth)

11737 REGGE TRAJECTORIES BY THE SCHWINGER VARIATIONAL PRINCIPLE. Kaufmann, William B. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 164: 1991-5(Dec. 25, 1967). (UCRL-17574).

The Schwinger variational method is adapted to compute Regge trajectories for the Schroedinger equation with Yukawa potentials. (auth)

11738 LOWER BOUNDS FOR THE ABSORPTIVE PART OF THE SCATTERING AMPLITUDE AT HIGH ENERGY. Bessis, D.; Kinoshita, T. (CERN, Geneva). Nuovo Cim. (10), 53A: 146-57(Jan. 1, 1968).

Within the framework of relativistic Mandelstam representation, a study is made of the analytic continuation of the partial-wave amplitude a(l,k) into the lower half k-plane, where k is the center-of-mass momentum, for complex values of the angular momentum l. By constructing an envelope of meromorphy for a(l,k), it is shown that for $4\mu^2(1-\delta) \le s \le 4\mu^2$ the t-channel absorptive part $A_t(t,s)$ cannot decrease faster than $t^{-1-\epsilon}$ as $t \to +\infty$, where $\epsilon = (N + 1/\pi)\sqrt{\delta/3}$ for $0 < \delta \ll 1$ and N is the number of subtractions in the Mandelstam representation. It is shown further that $\sigma_{total}(t)$ has a lower bound $t^{-(N+5)/2}$ for $t \to +\infty$. (auth)

11739 REMARK ON THE FREEDOM IN THE DEFINITION OF REDUCED M-FUNCTIONS. Goldberg, H. (Univ., Tel-Aviv, Israel). Nuovo Cim. (10), 53A: 286-91(Jan. 1, 1968).

Reduced M-functions (RMF)—associated with the M-functions introduced by H. P. Stapp—are defined in a way which depends on 6 parameters. The physical significance of the analytic properties of the RMF is questioned, since these properties may change under change in the definition. (auth)

11740 TESTS OF AN APPROXIMATE SCATTERING AMPLITUDE. Abbe, W. J. (Univ. of Michigan, Ann Arbor). Nuovo Cim. (10), 53A: 221-31(Jan. 1, 1968).

The results of a comparison of recent Regge representations for the scattering amplitude are given. The comparison is made to exact results for two attractive potentials: $-1.8e^{-r}/r$ and $-5e^{-2r}/r$. A representation with the Born term explicitly written is found to be a considerable improvement over another where it was not displayed. A one-pole approximation is seen to be fairly good at intermediate and higher energies, the agreement becoming worse as the potential becomes more attractive. It is hoped that the results may be useful in attempts to approximately satisfy the crossing relations. (auth)

11741 REGGEIZATION OF HELICITY AMPLITUDES. Drechsler, W. (CERN, Geneva). Nuovo Cim. (10), 53A: 115-36(Jan. 1, 1968).

A method of Reggeizing helicity amplitudes is investigated. The usual P-type functions $d^j_{\lambda,\mu}(z)$ which occur in the Jacob and Wick helicity formalism are replaced by the Q-type functions $e^j_{\lambda,\mu}(z)$ in terms of which Mandelstam's method of shifting the Sommerfeld–Watson contour into the left half-plane can be applied in analogy to the spinless case. The "nonsense channel" contributions are studied in detail especially with respect to the fixed singularities of the partial-wave amplitudes. The modification of the formulas due to possible branch cuts in the j-plane are given, and the behavior of the Regge-pole contributions to the helicity amplitudes is discussed when a trajectory passes through a "nonsense" value of angular momentum. (auth)

11742 CONSPIRACY AND SUPERCONVERGENCE PROPERTIES OF SCATTERING AMPLITUDES IN THE HELICITY FORMALISM. Bardakci, K.; Segre, G. (Univ. of California, Berkeley). Nuovo Cim. (10), 53A: 56-68(Jan. 1, 1968).

It is shown how conspiracy conditions for s-channel helicity amplitudes may be obtained directly, without using crossing. It is also shown how superconvergence relations, usually interpreted as restrictions on the scattering amplitude at fixed t for $s \to \infty$, may be reinterpreted as restrictions on an equivalent set of amplitudes for $s = s_0(t, m_i^2)$. For equal masses $s_0 = 0$, and superconvergence and conspiracy conditions coincide. Problems of saturation are briefly discussed. (auth)

11743 STATIONARY AND NONSTATIONARY QUANTUM PROBLEMS SOLUBLE BY THE CONTOUR INTEGRAL TECHNIQUE. Demkov, Yu. N.; Osherov, V. I. (Leningrad State Univ. Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 1589-99(Nov. 1967). (In Russian).

It is shown that if the energy operator consists of a time-independent part H_0 and a perturbation which linearly depends on time and is a projection operator of onto a certain state $|\varphi\rangle$, then the exact solution of the Schroedinger equation can be de-

rived in the form of a contour integral. The S-matrix for such a problem possesses the triangularity property and can be decomposed into elementary Landau–Zinger factors, each of which mixes only a pair of states. Similar results were obtained for the corresponding stationary problem. Some generalizations and examples are considered. The relation of the results to previous work on electron detachment and on ionization in collisions between atoms and ions are also considered. (auth)

11744 MODEL THREE BODY PROBLEM. Alexandrov, Igor. Los Angeles, Univ. of California, 1967. 141p.

Thesis.

A study is made of a known exactly soluble three-body problem, the McGuire model. The model is a quantum mechanical description of a one-dimensional three-particle system of equal masses, interacting via delta function potentials. Firstly, the model is used to test the frequently made contention that the Born series for rearrangement collisions must diverge. This is shown to be incorrect. Secondly, the model is modified to exhibit inelastic processes. It is known that the McGuire model for the equal coupling constants case exhibits rearrangement as well as direct scattering, but no break up or capture reactions are possible. However, when one of the pair-interaction-coupling constants is changed, break up and capture reactions can take place. The corresponding amplitudes are calculated by perturbation theory. The effect of using the McGuire solutions as compared to simple plane waves is studied. Thirdly, the McGuire model is formulated in terms of the Faddeev equations. The cases of a three particle bound state, of scattering of a free particle by a bound pair, and of scattering of three free particles are examined. A technique is found for formulating perturbation theory in terms of the Faddeev equations. The effect of perturbations calculated by means of this technique is compared with the results of simple perturbation theory. (Disser. Abstr.)

11745 HIGH ENERGY COLLISIONS OF ELEMENTARY PARTICLES. Eden, R. J. New York, Cambridge University Press, 1967. 306p. $9.50.

A survey is made of the types of experiments that are made on high-energy collisions and the kinds of theoretical approach to their interpretation. A number of standard techniques are described. Analytic properties of collision amplitudes are introduced, and from them the Regge theory of high-energy collisions is developed. The elementary parts of this theory are given in detail, and a survey and discussion are given of the more complicated aspects. Rigorous theoretical results are also presented, and the phenomenology and an experimental comparison of theoretical models are given. (J.F.P.)

Particle Accelerators

Refer also to abstracts 10581, 10654, 11206, 11409, 11485, 11607, 11629, 11886, 11944, 11948, and 11980.

11746 (CEA-R-3065) ETUDE DE LA PREPARATION DE CIBLES DE PALLADIUM ET DE TITANE CHARGEES EN DEUTERIUM POUR LA GENERATION DE NEUTRONS. (Study of the Preparation of Deuterium-Containing Palladium and Titanium Targets for Neutron Generation). Latrous, Habib (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 54p. (In French). Dep.

After briefly reviewing the use and production problems of tritiated and deuteriated targets, the following topics are treated: 1) Charging of palladium and titanium wires; 2) Contribution to structural studies concerning palladium and titanium deuterides; and 3) Charging of targets and neutron production tests. The conclusion stresses the fact that electrochemical charging is not of very great interest for the preparation of deuterated or tritiated targets, but makes it possible nevertheless to study effectively the structure of the deuterides. (auth)

11747 (CEA-R-3238) CALCUL DE PROFILS POLAIRES DESTINES A DES AIMANTS D'ACCELERATEURS DE PARTICULES. METHODE DES COURANTS ET METHODE DES TRANSFORMATIONS CONFORMES. (Calculation of Pole Profiles for Design of Particle Accelerator Magnets. Equivalent Currents and Conformal Representations Methods). Jaidane, Salah (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 151p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

Two methods allow the determination of the shape of the poles in magnets, for a given field distribution in the air-gap. The principle of the first method is based on creating the desired field by means of current sheets in which one can adjust the density given in a polynominal form. For the right distribution of these currents, the equipotential corresponding to the magnetic potential of the excitation coils is calculated. The pole profile of the H or C magnet identified with this equipotential line will finally take the place of the distribution of the current sheets used in the calculation. Steel permeability is assumed to be infinite and Foucault current effects are neglected in the case variable fields. The second method is based on finding a conformal representation that maps the pole profile plane upon the upper half of another plane where the equipotentials are two half straight lines, and where the field problems are easier to solve. Steel permeability is again considered to be infinite and the coils far from the pole faces. (auth)

11748 (IFVE-OP-67-22-k) VLIYANIE VOZMUSHCHENII MAGNITNOGO POLYA V KVADRUPOL'NYKH LINZAKH NA FOKUSIROVKU CHASTITS. (Influence of the Magnetic Field Perturbations of the Particle Focusing in Quadrupole Lenses). Kartashev, V. P.; Kotov, V. I.; Rzaev, R. A. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. 10p. (In Russian). Dep.

Nonlinear aberrations caused by distortions of the magnetic field in quadrupole lenses are considered. Aberration graphical expressions for a quadrupole doublet focusing a parallel beam to a point stigmatically are presented. (auth)

11749 (IFVE-SKU-67-19-k) REZONANSNAYA β INZHEKTSIYA PO DVUM STEPENYAM SVOBODY β SINKHROTRONE S SIL'NOI FOKUSIROVKOI. (A Multiturn Vertical and Radial Resonance Injection in a Strong Focusing Synchrotron). Titov, V. A.; Shukeilo, I. A. (Institut Fiziki Vysokikh Energii, Serpukhov (USSR)). 1967. (In Russian).

A multiturn injection of the particles under conditions of a difference betatron resonance is considered. It is possible to increase a beam intensity if synchrotron acceptance is larger than injector emittance. In some cases a betatron frequency shift due to space charge forces may be decreased. Some calculations for the Serpukhov accelerator are given. (auth)

11750 (IPP-2/64) UNTERSUCHUNGEN AN EINER MODIFIZIERTEN DUOPLASMATRON-IONENQUELLE MIT ELEKTRONENOSZILLATION IM ANODENPLASMA. (A Modified Duoplasmatron Ion Source with Electron Oscillation in the Anode Plasma). Ulbricht, Peter (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1967. 17p. (In German). Dep.

A high-intensity modified duoplasmatron ion source with electron oscillation in the anode plasma is described. The special properties of the source are a large plasma sheath with small positive space charge forces and a hydrogen neutral gas density in the anode plasma of 1.8×10^{14} cm^{-3} corresponding to $p = 5 \times 10^{-3}$ torr. The source works in continuous operation with a discharge current of about 2A and provides an emission current of $I_e > 200$ mA. In spite of an emission hole with a diameter of 5.5 mm the neutral gas pressure in the extraction gap remains about 1×10^{-5} torr. High field gradients can therefore be used. The emission current density, beam density distribution, and divergence of the extracted ion source parameters. (auth)

11751 (ORNL-TM-1990) SIMPLIFIED CALCULATIONS FOR SMALL DEFLECTIONS IN WALLS OF RADIO FREQUENCY CAVITIES. Howell, L. N. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 63p. Dep. CFSTI.

The elastic behavior of two types of radio frequency cavities considered for a separated orbit cyclotron was analyzed to determine whether or not the magnitude and distribution of the deflections in the walls of the cavities caused by atmospheric loading can be predicted and controlled. Expressions were derived for the elastic curves that describe the deflections in the walls, and methods were devised to study the structural parameters: the size, shape, wall thickness, and size and spacing of the stiffeners. Computer programs were written to perform the numerical calculations, and these methods of analysis were applied to different design conditions. It was concluded that flexural rigidities can be made to vary as required to obtain specific deflection patterns, but this principle is difficult to apply to any degree for the conditions and purpose considered. (auth)

11752 (SLAC-78) RF CAVITY FOR SLAC STORAGE RING. Allen, M. A.; Karvonen, L. G.; McConnell, R. A. (Stanford Linear Accelerator Center, Calif.). Oct. 1967. Contract AT(04-3)-515. 35p. Dep. CFSTI.

The electric design of the radiofrequency cavity for the proposed SLAC storage ring is discussed. Expressions are derived for the required tuning and coupling adjustments as a function of beam current. The mechanical design and fabrication are described in detail under the following categories: materials, fabrication stress relief, final assembly, flanges vacuum system, tuning, and cooling. The performance characteristics of the rf cavity are also presented. (B.G.D.)

11753 (UCD-CNL-91) A NOTE ON THE RF COUPLING SYSTEM. Hansen, Calvin F. (California Univ., Davis. Crocker Nuclear Lab.). Oct. 16, 1967. Contract AT(11-1)-Gen-10. 12p. Dep. CFSTI.

The coupling system used between the rf power amplifier and the main resonator tank of a cyclotron is discussed. (B.G.D.)

11754 SOME MODERN APPLICATIONS OF ELECTROSTATICS. Bright, A. W. (Univ. of Southampton, Eng.). Advan. Sci., 23: 81-91(June 1966).

Recent developments in electrostatics and various uses, including that in particle accelerators, are reviewed. In the development of devices to accelerate particles up to energies ranging from tens of kilovolts to many thousands of megavolts, electrostatic machines are preeminent in the energy range of 150 keV to 11 MeV. There has been a steady increase in the use of accelerators for industrial purposes, largely because electrostatic machines can now provide the very high voltages which are required, in a compact and safe form. When deuterons are accelerated to energies of the order of hundreds of kilovolts and allowed to strike a tritium target, neutrons are produced, providing so-called neutron sources. Examples are cited to illustrate the extent to which electrostatic machines have been developed. One such project, which is in an a advanced stage, is to provide a 150-keV electrostatic generator plus a neutron source which will be used for petroleum prospecting. The generator, which is of the Felici type, together with its neutron tube, is capable of being lowered down an oil bore hole 3 in. in dia to depths of up to 9000 ft. The generator can withstand operating temperatures of up to 150°C and pressures of around 5000 lb/in.^{2} A prototype of this generator has been built and satisfactorily tested; it is likely that the method will be widely used for oil prospecting. (BBB)

11755 DEVICE FOR INVESTIGATION OF THE STRIPPING REACTION WITH POLARIZED DEUTERONS. Saltykov, L. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 260-3(Feb. 1967). (In Russian).

Description is given of a device making use of polarized deuterons obtained from inelastic scattering on carbon accelerated to 13.8 MeV in a cyclotron. The polarized deuterons produced were employed in measurement of proton assymetry in the stripping reaction on ^{9}Be(d,p)^{10}Be and ^{10}Be(d,p)^{11}Be. (J PRS)

11756 METHOD OF MEASURING THE FREQUENCY OF RADIAL BETATRON OSCILLATIONS IN A SYNCHROTRON. Kulikov, O. F.; Shorin, K. N.; Yarov, A. S. At. Energ. (USSR), 23: 344-5(Oct. 1967). (In Russian).

In cyclic accelerators the distortion of the equilibrium orbit due to the nonsymmetry of magnetic characteristics is related in a definite fashion with the frequency of the betatron oscillations. The orbital radial displacement is determined by the expression: (1) $\Delta R_N = A_N \cos x_r(\nu - \theta) - A_{N+1} \cos x_r\theta - g_N/x_r$. Here N is the magnet sector number; $x_r = \sqrt{1-n}$, where n is the exponent of fall in magnetic field; $g_N = -(R_0/x_r)(\Delta H_N/N)$, where R_0 is the radius of the equilibrium orbit; H is the field on the equilibrium orbit; ΔH_N is the perturbing field; ν is the angular dimension of the sector; θ is the azimuth read from a definite edge of the sector. An expression is given for A_N. All the terms in equation (1) can be measured experimentally. The frequency of the radial betatron oscillations $\omega_r = \omega_0 N\mu/2\pi$. Here ω_0 is the orbital, electron rotational frequency. Thus measuring the frequency of the radial oscillations reduces to a simple determination of the orbital displacement during local perturbation of the magnetic field. The displacement in cross section of an electron bundle was recorded on a high-speed camera after applying a perturbing field, and was measured by microphotometry to an accuracy of 0.02 mm. The error in determining the actual displacement was 0.15 mm. After measuring ΔR_N the value of x_r was calculated from equation (1) and was found to have an exponent of n = 0.67 for the fall in magnetic field. This value of n was in good agreement with values of n obtained by other methods. (TTT)

11757 ELECTRON MODEL OF AXIALLY SYMMETRIC ISOCHRONOUS CYCLOTRON. Takeda, Tatsuoki; Arikawa, Tatsuo; Huke, Kazuo; Iwata, Gliti; Miyamoto, Goro (Tokyo Univ.). Jap. J. Appl. Phys., 7: 82(Jan. 1968).

An electron model of an isochronous cyclotron that utilizes a combination of axially symmetric electric and magnetic fields is briefly described. (W.H.K.)

11758 PULSED X-RAY RADIOGRAPHY WITH ELECTRON LINEAR ACCELERATOR. I. PRECISE CONTROL OF ELECTRON LINEAR ACCELERATOR. Kanaji, Toru; Yasuda, Kyoichiro; Ikuta, Shiro; Takeda, Michihiko (Government Industrial Research Inst., Nagoya, Japan). Jap. J. Appl. Phys., 7: 102-11 (Feb. 1968).

A control method is studied to make an electron linear accelerator radiate accurately the required number of pulses of beam. Counting circuits are used to pre-set the number of pulses. All parts of the accelerator are operated in a fully warmed-up state. A magnetic shutter is placed between the electron gun and acceleration tube to control the radiation. The phase relation between the periodical operation of the accelerator and the starting time of switching is chosen to take away the error caused by the transient state of the shutter. The coincidence of the accelerating field and injected electrons are controlled also to diminish the effect of unexpected radiation due to the leakage of the electrons through the shutter. The experiment shows that, the beam radiation is reliably controlled by this method, e.g., the quantity of the electrons included in each pulse is kept constant independently of the required number of the pulses. There is no indication which suggests that the beams radiated are not homogeneous. The intensity of the leakage radiation is small enough and not detected even by an ion-chamber roentgenometer. (auth)

11759 CALCULATION AND CORRECTION OF FIELD INHOMOGENEITIES OF A BETATRON. Hattori, Hiroyuki (Shimadzu Seisakusho Ltd., Kyoto). Jap. J. Appl. Phys., 7: 135-45(Feb. 1968).

The most important point to avoid the bumps or field inhomogeneities of a betatron is a precise air gap length between a pole and a yoke. When the air gap is longer, the phase lag of magnetic flux on the electronic orbit increases. However, the basic component of the bumps is caused by both flux distribution in the yoke and difference in length of the magnetic path in the yoke. Each magnet component has its own figure of bumps. Measured bumps are the sum of the bumps of the upper pole, lower pole and the yoke. The bumps can be regulated by turning the poles within a certain limit. Bumps of a yoke having two legs have some amount of the 2nd harmonic component. This 2nd harmonic component can be compensated with adjustable cores inserted in the yoke by pushing them toward the poles. (auth)

11760 THEORY OF FIELD STRENGTH DETERMINATION IN RF STRUCTURES BY PERTURBATION TECHNIQUES. Nakamura, Masao (Nagoya Univ., Japan). Jap. J. Appl. Phys., 7: 146-55(Feb. 1968).

The reciprocity principle is exploited for deriving perturbation formulas which relate the local electric and magnetic fields at the position of a perturbing body inside an rf structure to the fields induced by the body in an output lead or, in case of a resonant cavity, to the change in the resonant frequency or the quality factor of the cavity. The present theory applies to any rf structure which is linear and passive; it enables us to apply perturbation techniques to a wider class of structures than hitherto considered possible. It affords us a theoretical basis for some experimental methods which have been used without duly theoretical considerations. As one such example, absorption measurements of fields in Fabry-Perot resonators are discussed. Another example is measurements of travelling waves inside electron linear accelerator structures, for which a result of analyzing some experimental data is given. (auth)

11761 EFFECT OF NON-UNIFORMITY IN THE DISK-LOADED WAVEGUIDES OF ELECTRON LINEAR ACCELERATORS. Nakamura, Masao (Nagoya Univ., Japan). Jap. J. Appl. Phys., 7: 156-62(Feb. 1968).

The effect of incrementing dimensions of a cell in a periodic lossless cavity chain is shown to be represented by series reactances and shunt susceptances loaded on a uniform transmission line. Expressions for the reactances and susceptances are given in terms of the fields in the perturbed regions of the particular cell concerned. The treatment is then applied to the disk-loaded waveguides of electron linear accelerators and a numerical example is given. Some discussions are made on the effect of imperfections of one cell on the frequency of a resonant cavity formed by several cells including the imperfect one, on the mismatches inherent in gradient structures and on the implication of "tuning" of individual cells comprised in a fabricated guide. (auth)

11762 SPACE-CHARGE WAVELENGTHS IN ELECTRON BEAMS. Branch, Garland M. Jr.; Mihran, Theodore G.; Neugebauer, Wendell; Pohl, W. John (General Electric Co., Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.) Trans. Electron Devices, ED-14: 350-7(July 1967).

A basic parameter in the design of high-power klystrons is drift length measured in terms of effective plasma wavelength λ_q. Effective plasma wavelength can only be measured with beam probing equipment. The discrepancies between measured and calculated small-signal space-charge wavelengths are discussed, and it was shown that conventional methods of calculation are inadequate, causing errors up to 40% in a typical case. It was demonstrated that these errors cannot be explained by beam scalloping action, and that they are most severe when a high-perveance beam is used at low voltages with a high mag-

netic field under conditions of low interception. Although these effects would not be noticed with relatively short drift lengths, they may in many cases explain the critical variation of gain and efficiency with magnetic field. A more accurate method of calculating space-charge wavelengths was developed, and the effectiveness of this method demonstrated by a comparison with measurements. (BBB)

11763 RANDOM COINCIDENCE NOISE IN CORRELATION MEASUREMENTS IN A CYCLOTRON. Galkin, E. A.; Kosinov, G. A.; Kuyun, Yu, A.; Lagutin, I. G.; Nemets, O. F.; Sokolov, M. V.; Struzhko, B. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 264-6(Feb. 1967). (In Russian).

A brief description is given of the measures taken in 1963 to suppress the main destabilizing factors in the Physics Institute AS USSR cyclotron. The effect of destabilizing factors on the dee voltage was reduced 10–12-fold as a result of introducing automatic dee resonance contour control and voltage stabilization. (JPRS)

11764 ELECTROMAGNETICALLY OPERATED GAS VALVE FOR THE ION SOURCE OF PRESSURIZED VAN DE GRAAFF GENERATOR. Burger, Gabor; Gombos, Peter; Klopfer, Ervin; Kostka, Pal. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 363-6(1967). (In Hungarian).

An electromagnetically operated gas valve with a 2-mm-diameter, 7-mm-long channel is described. With a power consumption of about 15 W this valve makes it possible to change the accelerated particles from protons to deuterons in the Electrostatic Ion Accelerator of the Central Research Institute for Physics. The operation is carried out quickly and without opening of the pressurized vessel. (auth)

11765 ELECTROMECHANICAL SWITCH FOR THE REMOTE CONTROL OF HIGH VOLTAGE EQUIPMENT. Burger, Gabor; Klopfer, Ervin; Kostka, Pal. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 357-62(1967). (In Hungarian).

An electromechanical switching channel is described which permits the remote control of electronic devices within the high voltage terminal of Cockcroft-Walton or Van de Graaff particle accelerators. (auth)

11766 24,000 POUNDS OF URETHANE FOAM IN ATOM SMASHER. Mod. Plast., 44: 99(July 1967).

The waveguides used in the new Stanford University linear traveling wave accelerator are made of OFHC high conductivity Cu, which is about as soft as Au. To prevent the soft tubing from bending or buckling during transportation and installation (it will buckle under its own weight), the entire length of the tube, immediately after manufacture, was foamed with a 2-lb/ft^3 density polyurethane froth foam. This was done by suspending 25-ft lengths in a longitudinal clam-shell-type mold, 6 in. larger than the OD of the waveguide. The 3-in. thick coating adheres to the Cu with a strength exceeding the cohesion of the material itself. A total of 480 waveguides was involved in this project. The application of polyurethane foam also helped solve another problem, i.e., thermal expansion and contraction of the waveguides to the point where the energy wave would not travel through without distortion. Distortion can be brought about by the heat produced by the passage of extremely high-power r-f energy and the difference between ambient temperatures in the various components of the system. These conditions were met by first brazing small tubes to the waveguides before foaming. When the waveguides are in place, they are connected to a recirculating water-cooling system. The polyurethane insulates the tubes to maintain the waveguide at a constant temperature of 113°F with a tolerance of ±0.01°F. In all, about 24,000 lb of polyurethane was used in the Stanford linear accelerator. Since it was placed in limited operation in 1966, the foam plastic has functioned according to specifications. (BBB)

11767 HIGH FREQUENCY LINEAR ACCELERATOR OF ELECTRONS. Setvak, Martin (Faculty of Technical and Nuclear Physics, Prague). Jad. Energ., 13: 462-6(1967). (In Czech).

The experiences with the building and operation of the first Czechoslovak high-frequency linear accelerator of electrons for small energies are presented. The accelerator was built at the Faculty of Technical and Nuclear Physics in Prague with the aim of gaining the basic experiences of construction and technology of this kind of accelerator for construction of a prototype for greater energies for industrial and medical purposes. Such a protype is now being developed in industry; our machine has been used for physical research. (auth)

11768 THEORETICAL AND EXPERIMENTAL BEAM STUDIES FOR THE MICHIGAN STATE UNIVERSITY CYCLOTRON. Berg, R. E.; Blosser, H. G.; Gordon, M. M. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 58: 327-41(Jan. 1968).

Numerical orbit studies using Michigan State University cyclotron fields have been performed to determine the validity of use of the separated longitudinal equations of motion under conditions obtained in actual cyclotron operation. These results have been applied in a systematic study of phase measurement procedures using frequency and trim coil detuning. Direct experimental measurements were performed to determine the phase and phase width of the beam, as well as the betatron oscillation frequencies ν_r and ν_z, as a function of radius. From the phase history data the radial dependence of the rf dee voltage has been obtained, and the nominal initial phase φ_0 has been determined to be +20° ± 1° for the MSU central region geometry. Use of necessary computer calculations with this result gives an rf starting time τ_0 of −28° ± 1° for maximum beam intensity. Results of experimental measurements are compared with pre-computed orbit behavior where possible. (auth)

11769 ELECTRON BOMBARDMENT WEAK-FIELD IONIZER FOR A POLARIZED ION SOURCE. Vasil'ev, G. A.; Glasov, E. A. (Lebedev Inst. of Physics, Moscow). Nucl. Instrum. Methods, 58: 303-6(Jan. 1968).

An electron bombardment weak-field ionizer is described which is used in the source of polarized ions. The ionizer is characterized by high efficiency (2×10^{-3} for hydrogen atoms) and low power dissipation (120 W). A 3-keV ion beam produced has 1.5 mm dia. after being focused at a distance 250 mm from the ionizer. (auth)

11770 DESIGN CONSIDERATIONS FOR A SEPARATED TURN ISOCHRONOUS CYCLOTRON. Gordon, M. M. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 58: 245-52(Jan. 1968).

The objective of this machine is the production of large proton currents at energies from 200 to 1000 MeV with clear turn separation so that 100% beam extraction is achieved. Each stage of the cyclotron consists of a ring of identical magnet sectors interspersed with an appropriate set of rf acceleration cavities. The beam is injected from a linac thereby eliminating the central region problems associated with present isochronous cyclotrons. As a result of the narrow magnet gaps, the machine has relatively strong axial focusing throughout. The orbital frequency is high enough so that the beam can be accommodated within the space charge limits. Additional small third harmonic cavities provide for a flat-top on the resultant voltage wave form thereby allowing a relatively large phase width in the accelerated beam. Conditions for achieving clear turn separation are analyzed and found feasible. For a reasonable total number of turns, the isochronous field trimming requirements are quite tractable. Tentative design figures are presented and compared with the present Separated Orbit Cyclotron (SOC) designs. (auth)

11771 EMITTANCE MEASUREMENTS WITH A SINGLE GAP ACCELERATOR AND THE PRODUCTION OF VERY LOW EMITTANCE PROTON BEAMS. Wroe, H. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 58: 213-22(Jan. 1968).

A single gap accelerator with a duoplasmatron ion source is described and measurements of beam emittance, by the slotted plate and copypaper method, are given. It is shown that no large change in emittance occurs when the beam energy is raised from 40 kV to 350 kV. Values of normalized emittance are observed, varying between 3×10^{-6} and 10×10^{-6} cm · mrad for ion beams of tens of mA, which are much smaller than those obtained with conventional pre-injectors. (auth)

11772 MAGNET DESIGN FOR HIGH-ENERGY PHYSICS. Asner, A.; Petrucci, G.; Resegotti, L. (CERN, Geveva). pp 3-31 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The interplay between particle dynamics, experimental requirements and technological advances in determining the design of magnets for high-energy physics is illustrated by means of recent examples. The importance of digital methods of field computation is emphasized and the results of some practical applications are given. Some particular cases in which analytical approaches have proved adequate are mentioned, since they give a more direct insight into the physical problem. Some original solutions to special design problems, resulting from requirements on field level, space limitations, time dependence and momentum band are described. (auth) (UK)

11773 ANALYTICAL METHODS FOR WINDING CONFIGURATIONS OF IRONLESS BEAM TRANSPORT MAGNETS AND LENSES. Asner, A.; Iselin, C. (CERN, Geneva). pp 32-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Several methods have been developed for the analytical computation of magnetic fields in ironless magnets and lenses with a circular or rectangular aperture. Some of them are particularly suited for the design of ironless, e.g., superconducting, magnets with constant current density over parts or over the entire coil volume. Based on the results, a superconducting quadrupole is being constructed. (auth) (UK)

11774 COMPUTERIZED CALCULATION OF THREE DIMENSIONAL MAGNETIC FIELDS. Halacsy, A. A.; Clark, G.; Dunks, J. (Univ. of Nevada, Reno). pp 61-78 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The accuracy to which the magnetic field in the three-dimensional space must be known today can not be met by graphical field-plotting or by estimates such as the Carter-coefficient. The more accurate methods, like conformal mapping, are applicable only in two-dimensional planes, and not yet in a three-dimensional space. Three-dimensional methods are known, but usually they are calculations fitting only a particular geometry. Explicit formulas for such geometries, often with cylindrical symmetry, continue to be published signifying the need of more knowledge in this field. Though the need is great, still no general method exists. A graphical method described several years ago is applicable to any geometry, but its accuracy is insufficient, a common disadvantage of all graphical methods. It occurred to the authors that the process used in that graphical method might be computerized with the benefit of achieving any desired accuracy. It was found that the computer program can be quite generalized and used for the calculation of the magnetizing force due to a current the path of which can have any physical configuration. (auth) (UK)

11775 CARNEGIE MAGNET PROGRAM. Foss, M. H. (Carnegie Inst. of Tech., Pittsburgh). pp 102-5 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The program discussed was written for the CDC-G21 and uses features of the local monitor. For these and other reasons a listing of the program would be useless. However, in the course of writing this program some ideas were incorporated which may be of more general use: 1) By means of a subroutine the program was modified so that it will calculate 2- or 3-dimensional, cartesian or cylindrical problems. 2) In order to make the program fast, separate routines are provided for complex boundary calculations and simple interior points. 3) To minimize the space required for data storage the data for a complicated point is put in a list. The address of the list is associated with the mesh point. 4) The program is run by a set of instruction cards. The instruction is executed, or a brief explanation of the action taken, and the reason is printed. There are control orders which test and skip. There are orders which print out all results so that the user may convince himself that the program is working. To save space in memory the program can even read in program. 5) The convergence problem was examined. This led to the development of a procedure which can in principle eliminate all errors. (auth) (UK)

11776 FOCUSING PROPERTIES AND CHOICE OF PARAMETERS FOR BEAM TRANSPORT MAGNETS. King, N. M.; Wilson, E. J. N. (Rutherford High Energy Lab., Chilton, Eng.). pp 106-13 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

A common requirement in beam design is to refocus a diverging beam, or to turn it parallel, using a quadrupole doublet. A number of different solutions is possible, involving different location and excitation of the units. A method is presented for solving this problem, and solutions quoted in graphical form for the Focus to Parallel doublet. An analytic approach employing matrix methods for thick lenses reveals an optimal relationship of doublet strength and spacing which, expressed in suitably normalized parameters, allows investigation of the effect of scaling quadrupole parameters on acceptance. This is thought to be of particular importance in selecting magnet parameters for future accelerators. (auth) (UK)

11777 DESIGN OF ALTERNATING GRADIENT BEAM TRANSPORT MAGNETS. McPherson, G.; Wilson, E. J. N. (Rutherford High Energy Lab., Chilton, Eng.). pp 114-20 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Most proton synchrotrons now have facilities for extracting the full energy circulating proton beam. The extracted beam is focused on to a target in the experimental area, from which secondary beams fan out to high energy physics experiments. These beam channels should view the target at as small an angle as possible, in order to take advantage of the angular distribution of secondary particles, which falls rapidly with angle. Moreover, the first quadrupole focusing magnet in a secondary beam, which determines the solid angle, and hence the flux, should be as close as possible to the target. It is difficult to satisfy both these requirements and at the same time avoid placing magnets in the path of the residual proton beam. An alternating gradient magnet, which would perform the focusing function of a quadrupole doublet, and at the same time deflect secondary beams away from their neighbours and away from the extracted beam, would help to resolve this difficulty and would either afford an increase in the flux collected by beams or allow more beams to share the same target. The design of such a magnet is discussed. A theoretical description of the field of an AG magnet is presented, which leads to the dimensionless parameter γ, a convenient measure of the relative focusing and deflecting strengths of the magnet. The choice of values for γ and beam aperture radius, $\underline{a}$, depends on particular beam requirements. It is envisaged that the magnet should have a basic yoke and excitation assembly to which pole profiles giving a range of values of γ and $\underline{a}$ may be fitted. In cross-section each of these profiles would be a portion of a rectangular hyperbola; the derivation of the equation of this hyperbola for given values of γ and $\underline{a}$ is discussed. Ideally, the pole surfaces would be infinite in extent, but in practice one must decide on a pole width which, appropriately shimmed, yields a region of sensibly linear field over a circular aperture (radius $\underline{a}$). Suitable pole widths and shim configurations for the profiles may be derived by conformal transformation of results already computed for simple dipole magnets. The design of a suitable coil-yoke assembly is discussed. (auth) (UK)

11778 BEAM HANDLING MAGNETS FOR NIMROD. Bendall, R. G.; Newman, M. J.; Sheehan, M. J.; Wilson, E. J. N. (Rutherford High Energy Lab., Chilton, Eng.). pp 121-8 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The range of beam transport magnets which are in use in Nimrod's experimental area is described, and an attempt is made to convey the philosophy that has been adopted in fixing the parameters of the basic designs commonly in use, without presenting detailed calculations. Methods of construction and techniques of field measurement which have been employed in the design and testing of these magnets are described. Two of the more unusual designs of beam transport magnets developed at the Rutherford Laboratory are discussed; these are the Figure-of-Eight Quadrupole and the Spectrometer magnet. (auth) (UK)

11779 ENERGY AND FORCES IN TWO-DIMENSIONAL MAGNETIC FIELDS. Beth, R. A. (Brookhaven National Lab., Upton, N. Y.). pp 135-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Some new methods for the analysis of field energy, and forces on conductors, in two dimensional magnetic fields are presented. (auth) (UK)

11780 FAST STEPPING MAGNET. Elliott, R. T. (Rutherford High Energy Lab., Chilton, Eng.). pp 281-90 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Separated particle beams derived from Nimrod have, to date, been vertically defocused immediately prior to their injection into bubble chambers, in an attempt to make full use of the chambers' fiducial volumes. The sweeper magnet developed at CERN permits particle marking when used in conjunction with a particle identification system, but as with the defocused beam, the spatial separation of primary trajectories at the bubble chamber beam entry window remains subject to statistical fluctuations in machine fast spill, and also to any fine structure superimposed upon the spill by machine r.f., which affect the time distribution of particles transported to the bubble chamber. Stepping magnets have been developed at Berkeley and also at CERN to eliminate variations in trajectory spacing, thereby improving utilization of the bubble

chamber liquid volume. Similar in concept to the CERN device, the magnet developed for the K9 beam at the Rutherford Laboratory is intended to provide up to 15 well-defined channels for primary trajectories in the 1.5 m hydrogen bubble chamber, so that film will lend itself more readily to automatic data handling and processing. Track labeling on the bubble chamber film can be offered as a reliable facility, since each trajectory becomes associated with a unique state of the magnet and a corresponding bubble chamber channel. (auth) (UK)

11781 MAGNET DESIGN OF THE BONN 2.3 GeV SYNCHROTRON USING THE RELAXATION METHOD. Drees, J. (Univ., Bonn). pp 276-80 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

A strong focusing electron synchrotron has been installed in Bonn and brought into operation. The planning, the construction, and some results of the measurements of the A–G magnets are described. In order to achieve a short construction time the pole profile and the cross section of the magnet were fixed by means of computer calculations, and manufacturing of the magnet blocks was started without testing any magnet model. The calculations were based on the relaxation method. The influence of saturation effects was included. (auth) (UK)

11782 STATIONARY DELAY LINE MAGNETS USING FIELD CONCENTRATION. Kuiper, B.; Pichler, S. (CERN, Geneva). pp 214-25 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Two new types of delay line deflector magnets are proposed. These are of a hybrid construction, i.e., stationary magnets with fixed pulse connections, in which the stored magnetic energy is reduced by concentrating the field around the particle beam. Two ways of field concentration are discussed; one using moving magnet poles; the other using moving eddy current shields. In both methods relatively small masses are moved in a resonant motion, and several of the technological problems of either the full aperture or the small aperture magnets are avoided. (auth) (UK)

11783 THE FOCUSING SYSTEM OF THE NEW NEUTRINO BEAM LINE OF CERN. Asner, A. (CERN, Geneva). pp 226-39 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The problem of nonclassical, polychromatic focusing of charged particles, especially in connection with high intensity and high energy neutrino beams, is examined. In contrast to the use of classical beam transport channels, designed to deflect, focus and separate monochromatic beams of a specific momentum, high energy neutrino beams are obtained by focusing the spectrum of "neutrino parents," the charged secondary pions and kaons, covering a wide angular and momentum band. Since both the neutrino intensity and momentum greatly depend upon the focusing angle of the neutrino parents with respect to the detector, a very efficient focusing system is required. The basic equations for polychromatic focusing in conical, coaxial, high current pulse-excited magnetic horns and reflectors are given and the advantage of a cascade focusing system is discussed. As an example the design, layout and the technological problems associated with the construction of the focusing elements of the CERN new neutrino beam, consisting of a 300 kA-magnetic horn and two 400 kA-magnetic reflectors, are discussed. The new beam line has been performing successfully since March 1967. (auth) (UK)

11784 LARGE QUADRUPOLE MAGNETS WITH PRECISE FIELD. Taylor, E. (Stanford Univ., Calif.). pp 240-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Magnets have been built to parameters tested by computations, and even included an unusual floating turn in the windings, which was expected to improve the field accuracy. They have proved to be of exceptionally high quality and are in successful operation in the 8 BeV/c and 20 BeV/c Spectrometers at the Stanford Linear Accelerator Center. Some of the design features of the magnets are described. (auth) (UK)

11785 THE NEW BARE KICKER MAGNET OF THE CPS FAST EJECTION SYSTEM. Kuiper, B.; Milner, S. (CERN, Geneva). pp 204-13 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

An improved delay line kicker magnet was constructed and successfully operated with the CERN Proton Synchrotron fast ejection system. It should be less radiation sensitive, and its better performance should give more operational margin in conjunction with the 2nd and 3rd ejection channels. The electric parameters of this magnet are similar to those of the previous magnets. The original canned, polyethylene-insulated and silicon oil impregnated construction was changed to the use of insulation, and avoiding organic material. The H.V. pulse connections have been better adapted and remote operated mechanical current commutators have been incorporated. The construction of the magnet and its performance in the first physics run with the CPS are described. (auth) (UK)

11786 MAGNETIC PROBLEMS IN THE DESIGN OF ISOCHRONOUS CYCLOTRONS. Ricken, H. G. (Friedr. Krupp Huettenwerke AG, Bochum, Ger.); Thimmel, H. M. pp 256-61 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The magnetic field of isochronous cyclotrons is characterised by the independence of time and the azimuthal field variation, it is necessary to realize the magnetic field with high accuracy. The potential equation div (μ(|gradV|)). gradV = 0 with μ = permeability, V = magnetic potential, where the magnetic field in the medium plane is known from beam dynamics considerations, should be used to determine the geometry of the pole tips. The numerical treatment of this problem by means of computer techniques has been tried by several authors, and it seems that the accurate realisation of magnetic fields will be possible by this means. Up to now, however, model magnets have been used to develop the magnetic field for isochronous cyclotrons. The difficulties associated with this method are discussed. An estimation of the field errors caused by errors of permeability is made, and the measures taken by the steel mill, during the design and construction period of the Jülich Isochronous Cyclotron, in order to get small errors of premeability, are described. (auth) (UK)

11787 DESIGN OF THE GUIDING MAGNET FOR THE ETH 500 MeV ISOCHRONOUS CYCLOTRON. Tschopp, P. A. (Oerlikon Engineering Co., Zurich); Willax, H. A. pp 262-75 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The ETH cyclotron (ETH = Eidgenössische Technische Hochschule: Swiss Federal Institute of Technology) is a two-stage isochronous cyclotron consisting of a more conventional 70 MeV isochronous injector cyclotron (first stage) and a sectored isochronous ring cyclotron (second stage) accelerating protons to 500 MeV. The guiding magnet for this ring cyclotron consists of 8 separated sector magnets occupying about $\frac{1}{3}$ of the cyclotron azimuth. The stringent requirements on isochronism and focusing for beam orbital stability with the interdependence of the magnetic factors of sector width, field strength and spiral angle as a function of radius, together with the space limitations imposed by accelerating cavities and vacuum chamber, called for an iterative design procedure, consisting of successive cycles of model measurements, data analysis and improvement, along with a continuing study of the overall design of the accelerator. These model steps included a 1 : 12 scale model and three successive 1 : 5 scale models, on which extensive magnetic measurements were carried out in order to determine the pole configuration, the coil location and shape, the fringe field effects including shimming possibilities, yoke cross-section and shape and the effect of irregularities of the pole surface, along with corresponding beam dynamical computations. The completed basic design of the guiding magnet has resulted in 8 sector units, each about 5 m long, 2 m wide, 5 m high and weighing about 250 tons. (auth) (UK)

11788 EXTRACTOR MAGNETS FOR NIMROD. Morgan, R. H. C.; Gresham, A. T.; Dawson, J. M. (Rutherford High Energy Lab., Chilton, Eng.). pp 291-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The proton beam extraction system at present in use on Nimrod involves the use of an energy-loss target which is moved rapidly to the inner side of the circulating proton beam, a radially focusing quadrupole magnet, and an extractor magnet. The latter two magnets have also to be moved rapidly from the back of the magnet ring to a position 20 in. radially outwards, just inside the circulating beam. The protons which strike the target lose energy, and the field of the main Nimrod magnet causes them to spiral inwards through the quadrupole to the extractor magnet, which

deflects them out of the Nimrod magnet field. Achromatic correction to the beam is applied by the gradient of the quadrupole field and the gradient of the extractor magnet field. After operation for some time initially with a quadrupole and an extractor magnet with a fixed field gradient, and subsequently with an extractor magnet with pole face windings to vary the field gradient, it was decided to modify the quadrupole field to bring the magnetic centre nearer the septum and also to reduce the septum thickness. It was also decided to produce a more reliable extractor magnet, and this involved increasing the water cooling of the main windings, improving the cooling of the pole face windings, and modifying the can to withstand one atmosphere internal pressure, thus eliminating the need for a complicated auxiliary vacuum system which has been used up to now. There was also a need for a general tidying-up of the design electrically and mechanically and to improve accessibility for maintenance. (auth) (UK)

11789 STATIC POWER SUPPLIES FOR LARGE PULSED MAGNETS. Fox, J. A. (Rutherford High Energy Lab., Chilton, Eng.). pp 373-90 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Except for fast cycling magnet systems of low mega-joule capacity, which use an inductor/capacitor distributed resonant circuit, there is at present no real practical alternative to rotating machine kinetic-energy storage as a method of obtaining large power pulses for cyclic excitation of magnets. Some method is needed whereby the conventional M–G set approach can be avoided and the high energy available in a modern public electricity power system is exploited without inducing a corresponding system disturbance of unacceptable dimensions. How this might be done, whether a directly connected pulse is technically feasible and how much it would cost in capital equipment and possible electricity tariff changes is discussed. The impetus for this study has stemmed jointly from power supply reliability considerations of the proposed 300 GeV accelerator and the record of M–G set failures at several large accelerator installations. The 300 GeV magnet pulse data have therefore formed the basis of detailed examination. The magnitude of its pulse power swing (±160 MW) is large and requires advanced study techniques, but splinter investigations have illustrated that the static device described should be applicable, using simpler computational techniques, to other cyclic or non-cyclic magnet loads of more modest pulse energies. (auth) (UK)

11790 DEVELOPMENT OF SATURATED REACTORS FOR NETWORK STABILISATION AS APPLICABLE TO MAGNET POWER SUPPLIES. Friedlander, E. (General Electric Co. Ltd., Birmingham, Eng.). pp 391-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The effect load fluctuations have on consumers' voltage in a given supply system depends on the ratio of the fluctuating load relative to the short circuit power at the common busbar. Fluctuating loads present an increasing problem to power supply systems due to their size rising more rapidly than the short circuit power of the systems. Most affected at present are power supplies to arc furnaces. The powers involved in this field have reached a limit where even the short circuit power of the 275 kV system is no longer sufficient to keep the voltage fluctuations within desirable limits. It would appear that interposition of a motor generator set could solve all problems of this nature, but an M. G.-set is expensive and increasingly so if the load fluctuations are violent. In addition, there is a limit to the mechanical stress to which machines can be subjected without risking an appreciable reduction of their life and correspondingly still greater expense. Although the supply conditions for a magnet as required in large particle accelerators are theoretically not as severe as for arc furnaces, the problems are similar. Developments which have taken place within the last 5 to 6 years can contribute to improved economy and reliability of service in the field of magnet power supplies. (auth) (UK)

11791 STABILIZATION OF THE MAGNET POWER SUPPLIES FOR THE NINA SYNCHROTRON. Brown, C. W.; Owen, K. E. (English Electric Co. Ltd., London). pp 400-8 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The stabilization of the ac and dc magnet power supplies for the 4-GeV electron synchrotron (NINA) built at Daresbury, Cheshire, by the Science Research Council is described. Random variations in the mains power supply frequency and voltage make it impractical to rely on direct ac magnet excitation. Of the various indirect excitation methods possible the pulse method was chosen because of its general operational flexibility and reliable performance record. The salient features of the stability specification of the bias and alternating flux control systems are described. (auth) (UK)

11792 EXCITATION AND ELIMINATION OF THE DELAY LINE MODES OF RESONANCE IN THE MAGNET POWER SUPPLY SYSTEM OF A FAST CYCLING ELECTRON SYNCHROTRON. Marks, N. (Daresbury Nuclear Physics Lab., Lancashire, Eng.). pp 409-20 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The delay line mode of resonance is a disturbance that is found in the power supplies of most fast cycling particle accelerators. Its importance lies in that when it is excited the equality of magnetic field around the accelerator is affected, and the particle beam can be either seriously disturbed or completely lost. Its mode of excitation, and means of eliminating this mode, are described, with special reference to the NINA accelerator. (auth) (UK)

11793 PARALLEL OPERATION OF MACHINES USED TO PULSE NIMROD 7 GeV PROTON SYNCHROTRON MAGNET. Brooks, H. C.; Baker, R. J. (Rutherford High Energy Lab., Chilton, Eng.). pp 421-31 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Experience obtained when operating the alternators of the twin motor alternator flywheel sets in parallel, with separate shaft systems, to pulse the Nimrod 7 GeV proton synchrotron magnet, is described. When originally commissioned the machines were not paralleled. The shaft systems of the machines were coupled mechanically to give zero phase displacement between the alternators. (auth) (UK)

11794 PRECISION STABILISED DC POWER SUPPLIES. Fry, M. G. J. (Brentford Electric Ltd., Crawley, Eng.). pp 432-50 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The high capital cost of the equipment of a modern high energy particle physics laboratory, and the largely unpredictable nature of future experimental equipment configurations, demand power supplies for the magnets of the beam transfer line which are versatile in use, with a wide range of controlled currents and voltages at the load busbars. Much higher stability is required than for normal industrial equipment and the term precision is arbitrarily defined as a 24 hr current stability of 10^{-4} or better (total excursion). Pulsed loads are often fed from the same supply busbars and the stabilised power supply equipments must deal with fast mains voltage transients of several per cent amplitude, as well as slow variations in mains voltage and load resistance of at least 10%. Typical of many specifications, a beam transfer line at present under consideration has a total dc capacity of 6.5 MW, while short term (1 hr) current stabilities of $\pm 3 \times 10^{-4}$ are required, with attenuation of self-generated ripple to the same level. At this level of installed capacity harmonic generation in the supply network, overall efficiency and power factor cannot be neglected. An attempt is made to review briefly some of the major considerations underlying the design of static (i.e., non-rotary) equipments to meet specifications of this nature, together with short references to some possible future developments. (auth) (UK)

11795 A HIGH STABILITY STEP PROGRAMMED POWER SUPPLY FOR NIMROD EXTRACTION MAGNETS. Gilbert, F. S. (Rutherford High Energy Lab., Chilton, Eng.). pp 451-60 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

The purpose of this power supply is to achieve an increase in machine utilization, by enabling the extracted proton beam of the Nimrod accelerator to be switched from one beam line to another and back again during the flat top time of each accelerator pulse. The flat top time is normally in excess of 500 ms. To achieve this the extractor magnet current has to be switched from one level to another in approximately 10 ms: twice in the same machine pulse. The range of energies on the original specification, coupled with

the requirements of a high current stability, and a stepping programme having top and step levels fully variable, has presented many problems. The approaches to these problems and the solutions arrived at are described. (auth) (UK)

11796 PERFORMANCE OF STABILIZED CONDUCTORS. Wilson, M. N. (Rutherford High Energy Lab., Chilton, Eng.). pp 482-6 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The measurements described were made in connection with a large superconducting bending magnet, to be constructed at the Rutherford Laboratory. The magnet will be used in a particle beam where reliable operation without attention over long periods of time is essential; the use of a fully stabilized conductor is clearly advisable. A large overall current density is needed for efficient coil design, so that it is important to rate the current carrying capacity of the conductor as highly as possible. An accurate determination of the maximum stabilized current (minimum propagating current) for a particular conductor is therefore needed. The experimental measurement of such currents is described. The heat transfer characteristics of boiling liquid helium form the most important aspect of the stability problem, and are discussed first. Four experimental tests of stability are then described and the results obtained from different conductors presented. Finally, the implications of these results with regard to magnet design are discussed. (auth) (UK)

11797 SYNCHROTRON POWER SUPPLIES USING SUPERCONDUCTIVE ENERGY STORAGE. Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). pp 589-98 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The purpose of this paper is to suggest, and invite comment on, a new concept in power supplies for proton synchrotron magnets. The magnet current is required to increase from zero to maximum in about one second, and back to zero in a similar time, this cycle being repeated continuously. The power supply must therefore be capable of storing the peak inductive energy, and also make up the resistive losses during the cycle. For the proposed 300 GeV accelerator the peak magnetic stored energy is 72 MJ, and the mean power dissipation 26 MW. If high field superconducting synchrotron magnets become feasible, the mean power dissipation will become negligible, but the stored energy will be at least four times as great (i.e., at least 1 MJ per GeV), so that power supplies providing 100 to 1000 MJ will be required. The usual choice is a motor-flywheel-alternator system, followed by rectifier conversion equipment. In the 10–100 MJ range it has proved difficult to achieve the necessary high degree of reliability, and alternative static systems have been proposed in which the energy is extracted directly from the electricity supply network. There is, however, a limit to the amount of energy which can be acceptably transferred in this way; the provision of accelerator power supplies may, therefore, become an increasingly difficult problem in the future. Superconducting coils can be designed to store large amounts of magnetic energy at reasonable cost, and a number of magnets with stored energies in the 100 to 1000 MJ region are not being designed and constructed. It is conceivable, therefore, that a superconducting energy storage system could be used as the basis of a simple and economic synchrotron power supply, provided an efficient and controllable way of transferring the energy can be devised. (auth) (UK)

11798 PULSED SUPERCONDUCTING MAGNETS FOR PROTON SYNCHROTRONS. Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). pp 594-8 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

One of the largest and most attractive applications of superconducting magnets would be to replace the conventional iron cored magnets in proton synchrotrons. By this means, large reductions in the size and cost of new accelerators might be achieved, or alternatively, higher energies for the same cost. Since, however, most of the cost of a new accelerator laboratory is in the building and staff requirements, perhaps of even greater significance is the possibility of increasing the energy of existing accelerators by a factor of 5 or more, at relatively low cost. This is of particular interest at the Rutherford Laboratory; if the feasibility of pulsed superconducting magnets can be established, consideration could be given to converting the 7 GeV synchrotron Nimrod to an energy of over 35 GeV in perhaps 7 to 10 years time. A preliminary assessment of the economic and design problems has been completed. A very brief summary of the latest position, including new experimental work in progress on pulsed superconducting magnets is presented. (auth) (UK)

11799 MAGNETIC MEASUREMENTS OF THE HARWELL VARIABLE ENERGY CYCLOTRON. Coupland, J. H. (Rutherford High Energy Lab., Chilton, Eng.). pp 669-74 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The full magnetic survey of the spiral-ridge, multiparticle variable energy cyclotron at UKAEA, Harwell, was carried out during the three months May to July 1965 using systems which had been developed for the ⅓rd scale model and the limited survey, steel field only, of the cyclotron magnet that was made soon after its erection early in 1964. As the apparatus and methods have general application to other magnets, the main features are described quoting references to more detailed accounts. A somewhat similar system has been used on the new NRL cyclotron in Washington. Comments are made in the light of experience, and some subsequent alterations are mentioned. (auth) (UK)

11800 PRECISE FIELD MAPPING AND REPRODUCIBILITY STUDIES OF THE CERN MUON STORAGE RING MAGNET. Brown, R. Armstrong (CERN, Geneva). pp 683-92 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

The CERN Muon Storage Ring (M.S.R.) magnet is a continuous weak focusing device, without straight sections, of 5 metres diameter at the centre of the air gap. The air gap dimensions are 55 mm height by 160 mm width. The muon storage region extends 50 mm either side of the central orbit. The field index is 0.132, equivalent to 9 Gauss/cm at the working field level of 17.2 kilogauss. During the measurement of the anomalous magnetic moment of the muon it is necessary to know the absolute value of the total magnetic field, averaged over the circumference of the M.S.R. magnet, to the highest attainable precision. Since the magnet aperture is not accessible during the measurements, the procedure adopted has been to map the field in detail before and after experimental runs; and also to monitor the field during the runs at a few points whose relationship to the map has been carefully established. The instruments developed for these measurements are described; an outline of the field stabilisation system is given, and some figures are deduced for the reproducibility of field maps and for the relationship between the average field and that measured by the monitor probes. (auth) (UK)

11801 SMALL VERSATILE ANALOGUE COMPUTER FOR PARTICLE TRACKS AND BEAM ENVELOPES. Hansford, R. N.; Aspley, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 707-21 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

There are advantages in using a particle track analogue computer in the following circumstances: (a) In the initial stages of a design it is useful to be able to set up a number of quadrupoles and bending magnets and immediately get the feel of the system by following particle tracks through it, and by seeing instantaneously the effect of altering the position or strength of any of the components. (b) In a complicated matching problem, e.g., when it is necessary to make a system achromatic over a wide range of energies, it is often quicker and easier to achieve the desired result by examining particle tracks than by writing a digital programme with a large number of constraints. (c) In the training and education of staff the trainee quickly feels at home with the equipment, and is able to appreciate the effect of changes in the components more quickly than with a digital computer. The improved version described gives a simultaneous display of particle tracks in the horizontal and vertical planes, and can also display the beam envelope in either plane. Systems of up to 20 quadrupoles or bending magnets can be computed. Edge-focusing and n-type magnets can readily be included. (auth) (UK)

11802 AN EXPERIMENTAL ANALYSIS OF 90^0 UNIFORM FIELD BEAM BENDING MAGNETS. Morris, W. R. (Rutherford High Energy Lab., Chilton, Eng.). pp 727-34 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

A description of the magnets and their functions is first given.

An outline of the analytical methods employed, and in particular the alpha particle method, is then given, with a summary of the results obtained. Finally the difference between the obtained and predicted values is discussed. (auth) (UK)

11803 PERMEAMETER. Henrichsen, K. N. (CERN, Geneva). pp 735-9 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

10,000 tons of special steel sheet will be required for the construction of the magnets of the CERN Intersecting Storage Rings. The magnetic properties of each batch of steel will have to be measured before acceptance. 10 to 20 samples will be measured daily over a period of 10 months. During the whole production period the accepted spread of the induction at 15 oersted will be ±2%. The tolerance on coercivity will be ±0.15 oersted. The semiautomatic permeameter described was designed on the basis of experience gained from the measurements of the steel for the CERN Proton Synchrotron magnet, and was used to measure steel samples during the study of the magnets for the Storage Rings and for the proposed 300 GeV accelerator. During this exercise it proved to be so useful that the same instrument will be used for the series measurements. (auth) (UK)

11804 FIELD TRIMMING COILS FOR THE HARWELL VARIABLE ENERGY CYCLOTRON: PRACTICAL PROBLEMS INVOLVED. Hewitt, A. G. (Rutherford High Energy Lab., Chilton, Eng.). pp 757-62 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.
See CONF-670705.

Early ideas on the form the Harwell Variable Energy Cyclotron trimming coils would take were coloured by the conflicting requirement of maximum field change per coil pair, and minimum reduction of available gap length. In addition, due weight had to be given to other factors of greater or lesser importance, e.g., radiation resistance, reliability, electrical and thermal properties, and vacuum properties. The relative importance assigned to the various properties and requirements resulted in trimming coils made from square section mineral-insulated copper cable having a hollow water-cooled copper conductor. (auth) (UK)

11805 CERTAIN CHARACTERISTICS OF THE U-10 LINEAR ACCELERATOR ELECTRON BEAM. Elemanov, T.; Takibaev, Zh. S.; Abdullin, A. G. Vestn. Akad. Nauk Kaz. SSR, No. 6, 58-64(June 1967). (In Russian).

The 3 MeV U-10 linear accelerator with a pulse current of up to 0.5 amps is widely used in the Kazak Republic, and it is of interest to measure the electron density distribution in air during a change in beam parameters in order to determine the optimum conditions of electron irradiation. The distribution of beam current measured perpendicularly to the beam directions is given at various distances from the exit window of the accelerator. An increase in angle of divergence is observed with decreasing magnetron current and increasing beam current due to electron scattering in the exit window and air layer. The distribution of ionization density was measured by allowing the electron beam to strike a plexiglass or aluminum disk of varying thickness. The electron energy increases on increasing the magnetron current and decreasing the beam current. The distribution of bremsstrahlung radiation in water as a function of the distance from the beam axis, and the variation of bremsstrahlung radiation intensity as a function of water depth are presented. The intensity of the bremsstrahlung radiation can be stabilized even with fluctuations in electron current. This characteristic is very important in using the accelerator for radiation therapy. (TTT)

11806 SYMPOSIUM INTERNATIONAL SUR LES ANNEAUX DE COLLISIONS A ELECTRONS ET POSITONS, SACLAY, FRANCE, 26–30 SEPTEMBRE 1966. (International Symposium on Storage Rings for Electrons and Positrons, Saclay, France, Sept. 26–30, 1966). Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. 182p. (CONF-660939).

Separate abstracts were prepared for thirty-nine of the fifty-nine papers presented. Nineteen papers were previously included in NSA as 21: 5434, 11874, 13759, 13760, 13761, 13762, 19099, 27287, 27288, 27464, 29705, 33820, 33824, 33825, 33826, 33827, 33828, 33829, and 33830. One paper was in summary form and was not abstracted for NSA. (B.G.D.)

For abstracts of individual papers see: 11576, 11622, 11623, and 11807–11842.

11807 FUNCTIONING OF THE 500-MeV ELECTRON–ELECTRON STORAGE RING. Barber, W. C.; Gittelman, B.; O'Neill, G. K.; Richter, B. (Stanford Univ., Calif.). pp II.2.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966, Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).
From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The modifications made to the Stanford storage ring in order to decrease the pressure and increase the life of the beam are described. The operational parameters at 500 MeV are tabulated. The operational tests made at 500 MeV are briefly described, and the results are reported and shown in graphic form. (J.S.R.)

11808 MEASUREMENT OF THE CHARACTERISTICS OF LOW INTENSITY ACO. Augustin, J. E.; Beck, R. A.; Belbeoch, R.; (and others) (CEN, Saclay, France). pp II.3.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).
From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The characteristics of the low intensity ACO were measured with 150-MeV electron beam. The principal parameters are tabulated. The systems used for the measurement of the beam position, beam dimensions, and beam intensities are briefly described. The orbital properties with respect to closed orbit faults, betatron stability, resonances, and nonlinearities are reported. The injection system used is similar to that described by Mills and Morin, a multiturn injection using a septum inflector magnet. The low-beam characteristics of dimension, lifetime, and acceleration are described. (J.S.R.)

11809 CHARACTERISTICS OF THE ACO HIGH INTENSITY BEAM. Augustin, J. E.; Beck, R. A.; Belbeoch, R.; (and others) (CEN, Saclay, France). pp II.4.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).
From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The characteristics of the ACO beam at intensities above 1 mA were described. The observation conditions were summarized. The effects of the beam intensity, number of betatron waves, and ions on the dimensions of the electron beam were measured. The lifetimes measured with intensities up to 30 mA show no Touschek effect once the contribution of the residual gas has been suppressed. The instabilities observed and their characteristics were described. Preliminary results on the two-beam behavior were summarized. (J.S.R.)

11810 RECENT EXPERIMENTS WITH CESAR (ELECTRON STORAGE AND ACCUMULATION RING AT CERN). Bruckner, A.; Hubner, K.; Jones, E.; Koziol, H.; Magnani, L.; Pentz, M. (CERN, Geneva). pp III.1.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).
From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The operational conditions during the recent series of experiments are described. A theory to explain the abnormal accumulation yields was proposed. According to the model the effect of the frequency background is to make the separator of the bucket permeable to particles on both sides of it. The theory was verified by experiment. The accumulation yields were measured from Γ = 0.53 to 0.83 and for the number of pulses accumulated up to 120. (J.S.R.)

11811 FUNCTIONING OF A SYNCHROTRON AS A STORAGE RING. Robinson, K; Voss, G. A. (Cambridge Electron Accelerator, Mass.). pp III.4.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).
From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The three principal elements of a storage synchrotron are the damping system, multicycle injection, and deviation device. Each of these elements is discussed. The luminosity and lifetime of the beam were calculated. The first experimental results were briefly reported. (J.S.R.)

11812 INVESTIGATIONS ON THE SELF-MAINTAINED COHERENT OSCILLATIONS IN THE STORAGE RING. Auslender, V. L.; Karliner, M. M.; Lazarenko, B. A.; Popov, S. G.;

Sedlyarov, I. K.; Skrinskii, A. N.; Shekhtman, I. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp IV.1.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The results of experimental studies on different types of phase instabilities in the positron and electron storage ring VEPP-2 and in the electron-electron storage ring VEP-1 were reported. The self-maintained phase oscillations of a bunch in its totality and its decay into two parts which oscillate differently were studied. The initiation of oscillations as a result of an interaction between the bunch and the 18th harmonic of the cavity was observed. The threshold current was measured as a function of the adjustment of the principal and auxiliary cavity. (tr-auth)

11813 THEORY OF THE COHERENT INSTABILITY OF RESISTIVE WALL OF A BUNDLE OF CHARGED PARTICLES. Derbenev, Ya. S.; Dikanskii, N. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp IV.3.1-3 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The effect of the finite conductivity of the walls of the chamber on the coherent movement of a bundle of finite length is discussed. The expression for the rate of decrease of the betatron oscillations is given. (tr-auth)

11814 EIGENFIELDS CREATED BY A BEAM OSCILLATING TRANSVERSALLY IN THE PRESENCE OF SWEEP ELECTRODES. Laslett, L. J. (Univ. of California, Berkeley). pp IV.5.1-5 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The electromagnetic fields produced by a nonbunched beam oscillating transversally between a series of identical pairs of sweep electrodes that cover effectively the entire length of the chamber were determined. (tr-auth)

11815 ELECTRON–ELECTRON SCATTERING AT 2 x 135 MeV. Budker, G. I.; Kushnirenko, E. A.; Naumov, A. A.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A.; Skrinskii, A. N.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp V.2.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The angular distribution of the electron-electron scattering for angles of 40 to 90° was measured by means of collisions of electron beams in the 2 × 135 MeV storage ring VEP-1. The measurements were made using a system of spark chambers with photographic recording. The experimental results confirm the validity of the laws of quantum electrodynamics up to 0.6 Fermi. (tr-auth)

11816 DOUBLE BREMSSTRAHLUNG IN THE ELECTRON–ELECTRON SCATTERING FOR ENERGIES UP TO 2 x 160 MeV. Golubnichii, P. I.; Onuchin, A. P.; Popov, S. G.; Sidorov, V. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp V.3.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The double bremsstrahlung in the electron-electron scattering during beam collisions in the storage ring VEP-1 was studied. Measurements were made for three values of the energy 2 × 43, 2 × 135, and 2 × 160 MeV. Two NaI(Tl) crystal counters with total absorption were used. The total cross section of this process and the energy distribution of γ agree with the results of the theoretical studies of V. N. Bayer and V. M. Galitskii. (tr-auth)

11817 STUDY OF THE BACKGROUND DUE TO THE ELECTRON BEAM IN THE EXPERIMENTAL DEVICES OF THE ORSAY STORAGE RING. Augustin, J. E.; Bizot, J. C.; Buon, J.; Haissinski, J.; Laplanche, F.; Marin, P. C.; Perez y Jorba, J.; Rumpf, F.; Silva, E. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp V.5.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The triggering rates of two spark chambers to be used in beam collision experiments were measured under different conditions and the results were analyzed. The first detector is designed for the detection of charged particles emitted at large angles and the second is for the detection of γ rays emitted at large angles. The experimental conditions for the measurement of the background were described. For the first device the effects of beam intensity, time distribution, random coincidences, spiraling particles, location of the background source, and form of the vacuum chamber and absorbents were determined. For the second device only the effect of beam intensity was determined. (J.S.R.)

11818 REPORT OF THE RECENT PROGRESS ON THE PHYSICS OF BEAM COLLISIONS (e^+e^-) AND DESCRIPTION OF SOME EXPERIMENTAL RESULTS WITH RESPECT TO A FAST TRIGGERING SYSTEM FOR THE DETECTION OF TWO-BODY ANNIHILATION PROCESSES. Dalphiaz, P.; Fortunato, G.; Massam, T.; Zetti, F.; Zichichi, A. (CERN, Geneva). pp V.6.1-8 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

A summary is given of the recent studies made on the physics of beam collisions (e^+e^-) at CERN. The studies summarized are the coupling of vector mesons with the electromagnetic field, the q^2 dependence of the isoscalar and isovectorial coupling with the electromagnetic field, law of conservation of the quantum number A and measurement of the mixing angle of (ω-φ), C invariance, lepton quarks, and study of the fine structure at the interior of a resonance. The fast triggering system for the detection of two-body annihilation processes is described. The results obtained with the system show that it is possible to construct a high efficiency device with fast logic circuits that will respond to the case where one of the two particles in the final state is a resonance decaying into numerous bodies. The logic circuits necessary for the device are described. (tr-auth)

11819 MONITORING DEVICE FOR γ RAYS FOR THE ORSAY STORAGE RING. Augustin, J. E.; Buon, J.; Haissinski, J.; Laplanche, F.; Marin, P. C.; Rumpf, F.; Silva, E. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp V.7.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

Two lead scintillation sandwich counters were constructed for the γ monitoring. The linearity of the pulse height was measured as a function of the energy and energy resolution for each counter. The precision of the annihilation monitoring is limited by the subtraction of the hits due to bremsstrahlung. (J.S.R.)

11820 SOME CONSIDERATIONS WITH RESPECT TO A LUMINOSITY CONTROL SYSTEM AT ADONE. Tazzari, S. (CNEN, Frascati, Italy). pp V.8.1-5 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The reactions that can be used to control the luminosity in Adone are reviewed. The precision possible for the different operating conditions is established. (J.S.R.)

11821 THE OUTPUT OF HIGH ENERGY ELECTRODES IN THE ORSAY STORAGE RING. Augustin, J. E.; Beck, R. A.; Belbeoch, R.; (and others) (CEN, Saclay, France). pp V.9.1-3 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The output of the high voltage feed is greater than was theoretically predicted. The variation of the limited current with the beam energy was measured. From the threshold at 140 MeV there is a linear dependence up to 400 MeV. The current is independent of the pressure in the chamber and the lifetime of the stored

particles. The phenomena are attributed to an interaction between the vacuum chamber and photons due to a scattering of the synchrotron radiation. The plain electrodes in one magnet were replaced by grid electrodes in order to reduce the electrode output. (J.S.R.)

11822 MAGNETIC DETECTOR FOR A 3-GeV ELECTRON-POSITRON STORAGE RING. Boyarski, A. M.; Brechna, H.; Bulos, F.; Diebold, R.; Richter, B. (Stanford Linear Accelerator Center, Calif.). pp VI.1.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

Investigations were made of a magnetic detector to be used with the proposed SLAC electron–positron 3-GeV storage ring. The design of this superconducting magnetic detector is shown including the superconducting magnetic coils and spark chambers and curves showing the standard deviation momentum resolution necessary for distinguishing particle pairs as a function of the particle energy, the estimated momentum resolution versus production angle, and the magnetic field at the axis of the compensated solenoid. Topics include the magnetic field requirements for the detector, the solenoid field configuration with the magnetic field aligned according to the beam direction, a comparison between the superconductor and classical conductor, and the solenoid detector design. (J.F.P.)

11823 MAGNETIC DETECTORS FOR ELECTRON AND POSITRON BEAM COLLISIONS. O'Neill, G. K. (Stanford Univ., Calif.). pp VI.2.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

An examination of spark chambers of different types shows that classical chambers with large gaps and streamer chambers are all usable as large-solid-angle magnetic detectors for a storage ring, but each of these chambers presents serious difficulties. A study was made of chambers having medium-sized gaps (5 to 10 cm) with transparent plates made of wire in order to determine whether they would be practical for this use. The design of the detector was worked out such that it possesses the following characteristics: no topological connection with the vacuum chamber of the storage ring, no field gradient along the trajectory, a large solid angle and a uniform resolution in accordance with the polar angle, and direct photography using a single camera without field or mirror glass. Also given is a list of requirements for a detector to be used with the Italian storage ring Adone. (tr-auth)

11824 DESIGN OF A MAGNETIC ANALYSIS SYSTEM FOR EXPERIMENTS ON THE STORAGE RING. Osborne, L. S. (Massachusetts Inst. of Tech., Cambridge). pp VI.3.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The design of a magnetic analysis system, using spark chambers with large gaps, is described. In order to obtain great precision in the localization, classical chambers with large gaps and inclined sides are to be used. The design of the resulting chamber is given. The photographic system for the interior of the chamber is described. (J.S.R.)

11825 CAGE DETECTOR FOR STORAGE RINGS. Wiedemann, H.; Steffen, K. G. (Deutsches Elektronen-Synchrotron, Hamburg). pp VI.4.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The two field configurations that would satisfy the requirements for a cage detector, azimuthal magnetic field rotating concentrically around the beam axis and a magnetic field parallel to the beam axis, are described. The two field configurations are compared with respect to the resolution in quantity of motion, effect on the stored beam, and technical aspects of the concept of a cage detector. (J.S.R.)

11826 DESIGN OF AN EXPERIMENT ON THE PRODUCTION OF MUON PAIRS WITH ADONE. Borgia, B. (Univ., Rome); Conversi, M.; di Capua, E.; Tau, L.; Barbiellini, G.; del Fabbro, R.; Pellegrini, C.; Tazzari, S. pp VIIa.4.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

An experiment was designed for the production of muon pairs with Adone. The interaction considered was $e^+e^- \rightarrow \mu^+ + \mu^-$. The experimental device and the detection instruments are described. (J.S.R.)

11827 STUDY WITH ADONE OF THE ϕ RESONANCE BY ITS DECAY INTO K^+K^-, INTO $\mu^+\mu^-$, AND INTO NEUTRAL PARTICLES. Amaldi, U. Jr.; Biancastelli, R.; Stein, P. (Istituto Superiore di Sanita, Rome). pp VIIa.5.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The data that can be obtained from the study of the different decay schemes are reviewed. The experimental device for each study is described. (J.S.R.)

11828 PROPOSITION ON A $e^+ + e^- \rightarrow p + \bar{p}$ EXPERIMENT TO BE MADE WITH ADONE. di Giugno, G. (Istituto Nazionale di Fisica Nucleare, Naples. Univ., Naples); Meneghetti, L.; Peruzzi, I.; Querzoli, R.; Sassi, E.; Troise, G.; Vitale, S.; Bartoli, B.; Silvestrini, V. pp VIIa.7.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The experimental arrangement for the measurement of the baryon form factors using the $e^+ + e^- \rightarrow p + \bar{p}$ interaction is described in detail. The sources of background, the interaction region, Adone itself, and cosmic radiation are evaluated. (J.S.R.)

11829 CORRECTOR ELEMENTS FOR THE SLAC STORAGE RING PROJECT. Morton, P. H. (Stanford Linear Accelerator Center, Calif.). pp VIIb.1.1-3 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

A study is made to determine if it is necessary to use turning quadrupoles to correct the linear couplings prediction between the vertical and horizontal motions. The use of sextupolar magnets to correct the variation of the betatron frequencies with momentum is discussed. (J.S.R.)

11830 EFFECTS OF TURNING QUADRUPOLES AND MAGNETS. Hereward, H. G.; Keil, E.; Young, J. (CERN, Geneva). pp VIIb.2.1-4 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

In order to suppress the effects of coupling due to errors in positioning of magnets, turning quadrupoles were designed for the ISR. Because of the limited space available, it is necessary at each moment to justify these quadrupoles. A study was made to determine how the coupling can be suppressed by means of turning quadrupoles. The fields and tolerances necessary were determined. The other effects that these quadrupoles can have on the motion of particles were analyzed. The effects of the calculations showed that the vertical dispersion coefficient of the moments is deteriorated if the betatron motions are decoupled by localized turning quadrupoles. (J.S.R.)

11831 BEHAVIOR OF THE ACO (ORSAY COLLISION RING) BEAM IN THE VICINITY OF THE LINEAR COUPLING RESONANCE $\nu_x - \nu_z = k$. Leleux, G. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp VIIb.3.1-3 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

In the vicinity of the linear coupling resonance $\nu_x - \nu_z = k$, the injected beam describes a trajectory different from the optimum. This behavior is explained by using an elementary coupling theory

and measurements of the wave numbers ν_x and ν_z as a function of the radial amplitudes of the oscillations. The calculations are made on the hypothesis of a coupling sufficiently weak not to disturb the system in the proximity of the resonances. (J.S.R.)

11832 PHASE INSTABILITIES IN THE ACO. Zyngier, H. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp VIIb.4.1 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

A comparison of the equations of synchrotron oscillations and of the equations of the accelerating voltage is made which leads to an expression of the new damping time constant as a function of the synchrotron oscillations. (J.S.R.)

11833 THE MUON STORAGE RING OF CERN. Farley, F. J. M.; Bailey, J.; Brown, R. C. A.; Giesch, M.; Jostlein, M.; van der Meer, S.; Picasso, E. (CERN, Geneva). pp VIII.1.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The muon storage ring was constructed to obtain a precise measurement of the abnormal magnetic moment of the muon. The operating parameters measured during a preliminary run of 5 hrs are reported. These are: variation as a function of time of the counting rate due to stored electrons, shape of the revolution frequency for stored μ^-, and the relative variation of the magnetic field in the magnet opening before and after correction of boundary effects. (J.S.R.)

11834 PRESENT STATE OF DEVELOPMENT OF THE INTERSECTION STORAGE RING (ISR) PROJECT. Johnsen, K. (CERN, Geneva). pp VIII.2.1-5 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

In 1965 the construction of the ISR was authorized. The present design with respect to orbit parameters, magnet, high frequency system, vacuum, beam transfer, and general arrangement is described. (J.S.R.)

11835 ARTIFICIAL DAMPING IN THE PROTON STORAGE RING OF CERN. Hereward, H. G. (CERN, Geneva). pp VII.3.1-2 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The density of stored protons in the CERN ISR will theoretically be augmented by making them pass through a suitable target, which can be an electron current. An approximate calculation of the scattering and time constants show that it will be difficult to exploit this effect in practice. (tr-auth)

11836 STORAGE RING FOR OBTAINING SYNCHROTRON RADIATION WITH VISIBLE SPECTRA. Robinson, K. W. (Cambridge Electron Accelerator, Mass.). pp VIII.4.1-2 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The conditions under which it would be possible to obtain synchrotron radiation with visible spectra using a storage ring with minute dimensions were determined. (J.S.R.)

11837 PRELIMINARY PROJECT OF A SMALL ELECTRON RING WITH HIGH INTENSITY. Bruck, H.; Potaux, D. (CEN, Saclay, France). pp VIII.5.1-2 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The preliminary design studies of a small electron storage ring with high intensity are described. A ring of dimensions reduced so that the device of injection and acceleration and the devices of magnetic structure with constant gradient have a single magnet is considered. (J.S.R.)

11838 EXPERIMENTS ON OBTAINING AN INTENSE PROTON BEAM BY THE METHOD OF INJECTION BY CHARGE EXCHANGE. Budker, G. I.; Dimov, G. I.; Dudnikov, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). pp VIII.6.1-7 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

Experiments made on an intense proton beam obtained by charge exchange with a beam of hydrogen atoms were reported. Studies showed that there is a limit to the current of circulating protons. This limit is connected with the aspect of coherent phase oscillations. No betatron oscillations could be detected during the accumulation process. The maximum photon density at the center of the bundle was $\sim 10^8$ cm^{-3}. The variation of the stored current was measured as a function of the h-f voltage. The measurement of the variation of the number of photons as a function of time elapsed since the end of accumulation showed that the lifetime of the beam at low intensity is 7 msec. The development of instabilities at high intensity was shown. (J.S.R.)

11839 DESY PROPOSITION OF A 3-GeV ELECTRON AND POSITRON STORAGE RING. Steffen, K. G. (Deutsches Elektronen-Synchrotron, Hamburg). pp VIII.7.1-5 of Symposium International sur les A neaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

A brief outline is given of the DESY design study on a 3-GeV electron-positron storage ring. Cross sections are given of the various parts of the storage ring and discussed. (J.S.R.)

11840 SYNTHESIS REPORT ON THE BEHAVIOR OF THE BEAM. Sessler, A. M. (CERN, Geneva). pp IX.1.1-5 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The history of studies on beam behavior in relation with beam collisions is outlined. The aspects of beam behavior requiring further study are indicated. The synthetic report is based on papers presented at the Conference and on other studies. (J.S.R.)

11841 PROGRESS ACCOMPLISHED IN THE AREA OF BEAM COLLISIONS. Sands, M. (Stanford Linear Accelerator Center, Calif.). pp IX.2.1-6 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

A summary is made of the data presented on the different aspects concerning the conception and operation of storage rings. Topics include guide fields, injection, high-frequency systems, beam lifetime, measurement and control, instabilities, and performances of the storage rings. Possible future developments are indicated. (J.S.R.)

11842 SYNTHESIS ON PHYSICS WITH STORAGE RINGS. Touschek, B. (Univ. Guglielmo Marconi, Rome). pp IX.3.1-2 of Symposium International sur les Anneaux de Collisions a Electrons et Positons, Saclay, France, 26–30 Septembre 1966. Beck, R.; Cremieu-Alcan, E. (eds.). Paris, Presses Universitaires de France, 1966. (In French).

From International Symposium on Electron and Positron Storage Rings, Saclay, France. See CONF-660939.

The experimental data obtained in the operation of the Stanford, VEP-1, VEPP-2, and ACO and presented at the Conference are summarized. (J.S.R.)

11843 SUPPORT FOR CHARGED PARTICLE ACCELERATOR MAGNET SECTIONS. Salsig, William W. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,364,636. Jan. 23, 1968.

The supports for a heavy load such as the magnets of a particle accelerator, in which a hinged structure restrains any tendency of the load to move horizontally while permitting vertical movement,

are described. The vertical load in turn is supported by a long column extending well below the surface of supporting soil within a broad vertical passage so that the column is not horizontally restrained by the upper soil layers. Thus the vertical and horizontal restraints on the load are independent, the former being derived from deep stable soil so that the load position is unaffected by settling of the upper layer. (AEC)

11844 NEUTRON GENERATOR WITH OCCLUDED GAS ION SOURCE. Ruby, Lawrence; Vuletich, Tony; Rechen, Joseph B.; Wells, Dale Kenneth (to United States Atomic Energy Commission). U. S. Patent 3,364,355. Jan. 16, 1968.

An ion source is described which includes an evacuated cylindrical insulator having parallel metallic film strips deposited on the interior walls, the strips being interrupted by gaps. On application of an electrical current pulse, to form an arc across the gaps, gas occluded on the strips is released and ionized to provide a cloud of ions. (AEC)

11845 EQUIPMENT FOR CONTROLLING AND MONITORING THE ELECTRON BEAM OF A HORIZONTAL-TYPE PARTICLE ACCELERATOR. Franke, Siegfried; Gross, Siegfried; Torge, Bernd-Dietrich (to VEB Transformatoren. Rontgenwerk Dresden). U. S. Patent 3,358,239. July 27, 1965.

Equipment for controlling and monitoring the electron beam of a horizontal-type particle accelerator is described. The probe system and its associated circuitry are presented. (TSS) (U. S. Pat. Gazette)

11846 PARTICLE ACCELERATOR. Leboutet, H. (to CSF-Compagnie Generale de Telegraphie Sans Fil). Canadian Patent 756,780. Apr. 11, 1967. Priority date Sept. 4, 1962, France.

A method of accelerating ions is described using traveling waves in which the particles to be accelerated move parallel to a delay line and synchronous with the phase velocity of the wave which propagates within this line. The line has a variable pitch but the velocity is less than relativistic. Continuous variation of the output energy of the accelerated particles is possible within a relatively wide band. A chain of cascade coupled cells allows a phase shift that is constant per cell and with a variable pitch. Change in the output energy is achieved by varying the power of the injected wave and/or the frequency. (F.S.A.)

11847 TRANSVERSE WAVE INTERACTIONS BETWEEN ROTATING ELECTRON BEAMS AND WAVE GUIDES. Schriever, Richard LaVerl. Salt Lake City, Univ. of Utah, 1967. 155p. Thesis.

Microwave interactions resulting in oscillation and amplification have been observed in cases involving a beam of rotating electrons in a wave guide. The interaction is a cyclotron resonance phenomenon which occurs when the rotating electrons are synchronized with the wave guide fields. Application of a general coupled-mode theory to specific rotating beam configurations is made. The dispersion properties of the normal beam modes and normal circuit modes are considered to find possible cases of synchronism which may result in favorable interactions. The coupled-mode equations are solved for important cases with the help of simplifying approximations to find the propagation constants of the waves which can exist in the system. Application of boundary conditions at the input to the interaction circuit completes the interaction description. An expression for gain for the wave guide circuit is defined. An experimental device has been built with a rotating electron beam in a rectangular X-band wave guide circuit. Experimental investigations reveal that the device is characterized by a backward-wave oscillation interaction. The observed interaction is found to be consistent with the results of the coupled-mode analysis. Oscillator pulsed power of 720 watts with an efficiency of about 10% and frequency tuning with magnetic field between 6.55 and 22.0 kMc has been observed. (TSS) (Disser. Abstr.)

11848 APPARATUS FOR CONTROLLING THE DURATION OF PULSES IN A BEAM OF CHARGED PARTICLES. (to Varian Associates). British Patent 1,097,989. Jan 3, 1968. Priority date Sept. 28, 1964, United States.

The design of an apparatus for pulsing a beam of charged particles is described. A cavity resonator is positioned between the particle source and the apertured collecting electrode. A pair of deflection plates are positioned between the first apertured electrode and a second apertured electrode. The deflection plates allow the beam to be swept across the second aperture by varying the electric field strength, and therefore the beam is pulsed. (W.H.K.)

11849 POWER SOURCES FOR A BOMBARDER-TYPE ELECTRON GUN. Imai, Takashi (to Kokusai Henatsuki K. K.). Japanese Patent 1966-14080. June 30, 1966. Filed Dec. 31, 1963.

Improved power sources are proposed for use in a bombardment-type electron gun. In the conventional power sources for this type of electron gun, a complicated pulse transformer is used, resulting in the high cost of electron guns. By the method proposed, the pulse transformer can be simplified, thereby reducing the overall cost. (NSA of Japan)

11850 DEVICE FOR AUTOMATICALLY CUTTING OFF A CHARGED-PARTICLE BEAM. Tanaka, Kazumitsu (to Japan Electron Optics Lab. Co., Ltd.). Japanese Patent 1966-14039. Aug. 5, 1966. Filed Mar. 28, 1964.

In charged-particle working machines, e.g., that use an electron beam, it is necessary to cut off the beam instantaneously when the work is complete. A peculiar device is proposed for this purpose; and many of the usual drawbacks, including inaccurate detection of the beam, destruction of the (detecting) electrode and considerably complicated construction, are eliminated. It consists of a means for irradiating a material; reflecting plate, painted with a luminous substance, behind the material, which emits light by charged-particle irradiation; a means for converting the received light into an electrical signal; and a means for feeding a signal (derived from the electrical signal) to the charged-particle beam generating system. By this mechanism, the beam of charged particles can be cut off instantaneously upon completion of the working. (NSA of Japan)

11851 DEVICE FOR DETECTING THE POSITION OF A CHARGED-PARTICLE BEAM. Nakayama, Norihiko (to Kobe Kogyo Corp.). Japanese Patent 1966-14076. Aug. 5, 1966. Filed May 8, 1964.

In particle accelerators, it is required to detect accurately the position of a charged-particle beam, in order to place the beam on its proper orbit or concentrate the accelerated beam on a small target. This is usually done by comparing the voltages induced in a number of rectangular electrodes, placed along the orbit of a charged-particle beam. The drawbacks are then the variation of output voltages with the beam energy, noises due to other interfering secondary-electrons, installation of the electrodes within the accelerating tube. The proposed device for detecting the beam position eliminates many of such defects. A plurality of pairs of magnetic cores, one opposing to the other, are installed (outside the accelerating tube), the charged-particle beam position is achieved by comparing the voltages induced in the winding around each magnetic core. (NSA of Japan)

11852 LINEAR PARTICLE ACCELERATOR. Nagai, Toshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-14880. July 11, 1966. Filed Dec. 2, 1963.

In the linear particle accelerator proposed, the mode transformer and the non-reflecting terminal, which are employed in the conventional linear accelerators, are removed by installation of a microwave absorber in the end of an accelerating tube. The resultant advantages are the elimination of some drawbacks attendant upon the conventional accelerators, and simple construction of a linear accelerator, with the result of a reduced cost. It consists of an accelerating tube; a charged particle source to inject charged particles into the accelerating tube; a microwave source for accelerating the charged particles in the accelerating tube; and a microwave absorber inserted in the end of the accelerating tube. (NSA of Japan)

11853 DEVICE FOR CORRECTING THE ORBIT OF A CHARGED-PARTICLE FLUX IN A LINEAR ION ACCELERATOR. Nagai, Teruo (to Mitsubishi Electric Corp. Mitsubishi Atomic Power Industries Inc.). Japanese Patent 1966-13080. July 22, 1966. Filed Apr. 28, 1965.

The device proposed is used for correcting the deflected path of a charged-particle beam to the central axis of the magnetic fields, produced by the many focusing electrodes which are in a series of the cylindrical electrodes. It consists of the following: a device for detecting the degree of deflection of a charged-particle beam with respect to the central axis of magnetic fields; the first orbit-correcting device for deflecting the path towards the central axis; the second orbit-correcting device for deflecting the orbit (from the first device) so as to be in the same orbit as the central orbit; and a device for producing a magnetic field of suitable intensity in both the first and second orbit-correcting devices upon receiving the signal from the detector. (NSA of Japan)

11854 CIRCULAR PARTICLE ACCELERATOR LIKE THE BETATRON. Suzuki, Toru (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-2958. Feb. 21, 1967. Filed Feb. 22, 1965.

In the circular particle accelerator proposed, the outer magnetic poles can be cooled very effectively in order to prevent the disturbance of a magnetic-flux distribution. The circular particle accelerator consists of the main (central) magnetic poles op-

posed to each other; the outer magnetic poles, outside the central ones, opposed to each other; the yokes for supporting these magnetic poles; the exciting coils wound around the outer magnetic poles; a circular accelerating tube, inserted between the two outer magnetic poles, with radial support pieces between so as to form radial spaces between the circular tube and the outer magnetic poles; and equipment, installed onto the yokes, for circulating cooling air between the circular tube and the outer magnetic poles, and through other spaces. (NSA of Japan)

11855 DEVICE FOR COOLING THE TARGET OF A NEUTRON GENERATOR. Tsujii, Tatsuo; Yoshida, Hisashi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-2957. Feb. 21, 1967. Filed Mar. 19, 1965.

By the method proposed, the target can be cooled uniformly and bubbles attached to it removed efficiently, thereby increasing considerably cooling of the target. A cooling water room is formed at the very end of the extension of an accelerating tube, immediately behind the target (plate). A coolant entrance and exit are provided to the room. A moving vane (or blade), which can be rotated by the force of coolant flow, is installed in the cooling-water room. (NSA of Japan)

11856 CHARGED-PARTICLE ACCELERATING DEVICE. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1967-2639. Feb. 16, 1967. Filed Jan. 16, 1965.

By the method proposed, a material can be irradiated with an accurately controlled number of charged particles. A detector for the number of charged particles is installed in the path of a charged-particle beam, between an electron gun and the material. When the detected number has become a specified value, a control signal is issued from the member. The light-signal member is controlled by this signal; a light signal is issued from the member. The electron gun is thus controlled by this light signal. By this means, a charged-particle beam, from the electron gun, can be stopped or started again for the desired purpose. (NSA of Japan)

11857 DEVICE FOR MEASURING THE OUTPUT OF AN ACCELERATOR. Inoue, Kiyoshi (to Hitachi Ltd.). Japanese Patent 1967-2760. Feb. 6, 1967. Filed June 3, 1960.

By the method proposed, the energy and the current of a charged-particle beam deflected and scanned can be measured simultaneously and independently by a single measuring device. A charged-particle measuring device, having a plurality of independent measuring units, is installed in the vicinity of the position of the maximum deflection angle, of an virtually monochromatic charged-particle beam deflected and scanned periodically by an ac magnetic field, so that the measuring units are in the direction of charged-particle scanning. An indication of the measured output is given through an amplifier; and the energy and the current of a charged-particle beam from an accelerator can be measured both simultaneously and independently. A saw-tooth or triangular wave form magnetic field is used as the ac magnetic field for deflection and scanning of the charged-particle beam, thereby simplifying the calculation necessary for measurement of the total output current. (NSA of Japan)

11858 CHARGED-PARTICLE BEAM IRRADIATION DEVICE. Takahama, Takeshi (to Hitachi Ltd.). Japanese Patent 1967-2960. Feb. 21, 1967. Mar. 1, 1965.

In the charged-particle beam irradiation device proposed, the exchange of an irradiation window can be done easily and also the cooling improved. As is usual, the flange is embodied at the end of the extention of an accelerating tube, and the irradiation window is fixed air-tight by means of the keep plate opposed to the flange. The packing is stuck to the flange and the (irradiation) window to the keep plate. (NSA of Japan)

11859 NEUTRON GENERATING DEVICE. Oishi, Mineo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-2956. Feb. 21, 1967. Filed Mar. 10, 1965.

By the method proposed, the target can be easily fixed and the remaining cooling water, when the target is removed, can be completely eliminated. It consists of an accelerating tube; a high-voltage source installed at one end of the accelerating tube; the extension tube at the other end of the accelerating tube; cooling-water conduit pipes installed along and to the extension tube; an end plate, holding the target, which can be readily fixed to or removed from the end of the extension tube; and a passage of cooling water through the end plate, which connects to the conduit pipes. (NSA of Japan)

11860 BETATRON. Takizawa, Teruo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-2959. Feb. 21, 1967. Filed Feb. 26, 1965.

In the betatron proposed, without any special facility in the betatron housing-room the iron core, style cover, and shield can easily be separated and assembled together in two halves. It includes the iron core, containing the magnetic poles for supplying a magnetic field and the accelerating magnetic flux to the circular accelerating tube, which is divisible in the direction of magnetic poles; a device for moving the divided parts in the said direction; the shields, installed at the positions not covered by the iron core, which are divisible in the said direction; and the style cover, divisible in the same direction, which encloses the iron core, moving device and shields. The style cover and the shields, when the iron core is separated in two halves by the said device can also be separated similarly, together with the iron core. (NSA of Japan)

11861 DEVICE FOR STABILIZING AUTOMATICALLY THE FOCAL POINT OF CHARGED PARTICLES. Kamiyama, Zenji (to Mitsubishi Atomic Power Industries, Inc.). Japanese Patent 1966-13077. July 22, 1966. Filed Apr. 28, 1965.

The device proposed is for a charged particle accelerator. It consists of the following: a component for focusing the charged particle beam; a flux measuring component, exposed to a part (at least) of the flux which is located near the focal point; a component for detecting the fluctuation of the focal point of the charged particle beam, by means of the electric current induced by the injection of charged particles into the component; and a component for supplying a magnetic field of proper intensity to the focusing device, by receiving a signal from the said detector. (NSA of Japan)

11862 DEVICE FOR FLOWING A GAS INTO A PARTICLE ACCELERATOR. Kawashima, Hideo (to Hitachi Ltd.). Japanese Patent 1966-12960. June 18, 1966. Filed Mar. 7, 1963.

Using the device proposed, the time required to evacuate the accelerating tube to a high vacuum can be reduced considerably, and also the flowing-in of a gas into the tube can be done remotely. The accelerating tube of a particle accelerator is in general operated under a high vacuum, but this accelerating tube is often filled with a gas to atmospheric pressure in order to check the inside conditions. In order to fill the tube with a gas, the need arises for evacuating it to a high vacuum with a vacuum pump, which usually takes a long time. Further, to flow a gas into the tube, it is done manually, with the results of difficulty in adjusting the flow rate, and in access to the accelerator. These drawbacks attendant upon the conventional methods are eliminated by the proposed device. It consists of an auxiliary vessel, directly connecting to the accelerating tube; a gas bomb, containing a dry gas lighter than air; and a bimetal-type gas valve in the path of a gas from the bomb to the vessel. This valve is made up, as follows. A metal axis of small expansion coefficient is surrounded by a metal pipe of a larger expansion coefficient than the axis, and the pipe is wound on the outside with a heating wire. (NSA of Japan)

11863 X-RAY IRRADIATION APPARATUS. Kimura, Hiroshi (to Hitachi Ltd.). Japanese Patent 1966-9459. May 20, 1966. Filed May 15, 1964.

With the proposed x-ray irradiation apparatus, associated with an electron accelerator, a relatively uniform x-ray distribution can be obtained over the large irradiation field. The electron accelerator, particularly the accelerating tube is inclined or revolved mechanically, with the end of the accelerating tube always pointing towards the target (to produce x rays), while the accelerator is operated. In this case, the target and the end of the accelerating tube may be connected by use of bellows. The axis of the accelerating tube invariably passes through a given point on the target, and so the electron beam is always focused onto this particular point. The angular distribution of the x-rays produced, as the accelerating tube is revolved, depends on the angle of inclination. (NSA of Japan)

11864 EXCITING DEVICE FOR A PARTICLE ACCELERATOR. Okada, Tsutomu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-14079. June 30, 1966. Filed July 9, 1963.

An improved exciting device, employing a high-Θ circuit, is proposed for a particle accelerator. By the method proposed, when a self-oscillator such as the magnetron is used as the microwave source with a high-Θ circuit for a particle accelerator, the oscillation frequency can be made the same as the frequency of the accelerating circuit without reducing the power, thereby increasing the acceleration efficiency. Furthermore, the exciting device has a stable performance. It consists of the following: a circuit for dividing the microwave output signal from the self-oscillator; a circuit, connected to a branch of the dividing circuit, for matching in the wide range of frequencies the load impedance from the said oscillator; a phase shifter for the phase of an output signal through the matching circuit; a circuit for synthesizing the output signal from the phase shifter and that from another branch of the dividing circuit; and the accelerating tube, excited by the output signal of the synthesizing circuit. (NSA of Japan)

11865 PULSED PARTICLE-BEAM GENERATOR. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1966-14077. June 30, 1966. Filed Sept. 16, 1963.

An improved pulsed particle-beam generator is proposed for a particle accelerator (to produce neutrons), electron-beam working machine and electron-beam melting device. The pulsed particle-beam generator proposed has no movable parts in the vacuum penetrating from the outside, and also no auxiliary electrodes such as the deflecting plate. The lens system of the generator for focusing a beam from the ion source or electron gun consists of the following: the first electrode kept at the same potential as the support plate for the ion source; the second electrode to which a focusing voltage is applied; and the third electrode to which a pulsed (or high-frequency) voltage is applied from the voltage source located between the first and third electrodes. (NSA of Japan)

11866 PARTICLE ACCELERATOR. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1966-14078. June 30, 1966. Field Aug. 10, 1963.

In the particle accelerator proposed, the difference in the beam currents, produced in the slits of an energy analyzer when the adjuster is actuated, is detected by a differential amplifier, and the voltage of the power supply to the accelerator is automatically adjusted by the output of this detector. Compared to similar systems, the operation can be simplified although there are no improvements in the energy stability, etc. The particle accelerator includes the following: the accelerator proper, the power supply circuit, its voltage adjuster, a corona-current control circuit for the accelerator, an electromagnetic energy-analyzer for drawing out a necessary atomic ion beam from the (accelerator) output beam current, a current adjuster for adjusting the exciting current to the energy analyzer correspondent to the accelerating voltage, a target connected to the energy analyzer (on the output side), slits installed between the target and analyzer for drawing out the beam currents, a differential amplifier for detecting and amplifying the difference in the currents drawn out by the slits. When nuclear experiments are performed, with the particle accelerator, the beam current accelerated to a desired energy is applied to the energy analyzer, and only the necessary atomic-ion beam is drawn out by means of the output, which is then allowed to impinge upon the target. (NSA of Japan)

11867 BELT FOR A PARTICLE ACCELERATOR. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-12160. June 7, 1966. Filed July 25, 1962.

An improved belt for carrying charge is proposed for a particle accelerator. A plurality of cotton sheets (e.g., four) are piled up one upon another and are then pressed together while impregnating them with synthetic rubber. Thus, an endless belt to carry charge is formed. In this case, part of the contained rubber oozes out onto the surface of the produced belt, to form a thin surface layer. This layer serves to prevent the cloth from getting wet and also to reduce the surface friction. (NSA of Japan)

11868 PULSED CHARGED-PARTICLE BEAM GENERATOR. Maekawa, Akitsugu (to Hitachi Ltd.). Japanese Patent 1966-13680. June 27, 1966. Filed Mar. 11, 1963.

Using the pulsed charged-particle beam generator proposed, a pulsed charged-particle beam of extremely small pulse-width can be obtained. It consists of a charged particle source, a device for deflecting a pulse of charged particles from the source, and a barrier, with the central slit, for the deflected pulse. A pulsed charged-particle beam is injected from the source toward the slit (i.e., the accelerator). As this pulse of charged particles runs along its path a pulsed voltage of a suitable pulse-shape is applied to the deflecting electrode, thus deflecting the pulse of charged particles. In this case, the operation is done such that when a certain point in the rising (or falling) part of the deflecting pulse-shape is attained, the pulse of charged particles just passes through the slit of the barrier. Hence, only the part of the charged particle pulse, corresponding to the width with the point as the center, can pass through the slit, thereby giving a pulsed charged-particle beam of extremely small pulse-width. (NSA of Japan)

11869 ION SOURCE. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1966-20238. Sept. 24, 1966. Filed Feb. 26, 1964.

By the method proposed, the size of the ion source, which is for a plasmatron etc., can be reduced. It consists, as usual, of a filament, an anode, a middle electrode between the filament and anode, an arc power source connected between the filament and anode, and so on. The spacer piece for the middle electrode, inserted between the electrode and anode, is made of a material having both insulating property and magnetism. (NSA of Japan)

11870 CHARGED-PARTICLE PHASE BUNCHING DEVICE. Takeda, Yasutsugu (to Hitachi Ltd.). Japanese Patent 1966-7734. Apr. 25, 1966. Filed Jan. 18, 1963.

The method proposed makes compact a phase bunching device of the velocity modulation type, which is used as a part of a high-energy particle generator such as a linear electron accelerator. In general, the velocity-modulation phase bunching devices are of the two types. In one type, velocity modulation is applied to a charged particle beam in the cavity gap, and this beam is phase-bunched in the drift tube, which is devoid of an electric field. In the other type, a high-frequency wave to give continuously velocity modulation to a charged particle beam is maintained over a certain distance of travel of the beam, and at the same time phase bunching is produced to the charged particle beam. The method proposed can be applied in either of the two types. It includes the following: a charged particle source, a high-voltage pulse transformer to inject, and flow charged particles from the source; and a device, which phase-bunches the charged particles by excitation high-frequency waves. Part or all of the excitation high-frequency wave power is supplied from the excitation high-frequency wave source, through a coaxial cable wound around the high-voltage pulse transformer. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 10639, 11513, 11754, 11855, 11859, and 11917.

11871 (ANL-7318) MC^2: A CODE TO CALCULATE MULTIGROUP CROSS SECTIONS. Toppel, B. J.; Rago, A. L.; O'Shea, D. M. (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 330p. Dep. CFSTI.

The computer program MC^2, which was written to generate complete cross-section sets using an evaluated nuclear data file, is described. The mathematical formulation of the program is outlined, and a listing of the program is included. The program is written in FORTRAN for a 64-K CDC 3600 computer. (D.C.W.)

11872 (BNWL-472, pp 6.1-5) NEUTRON PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The experimental program to measure the total neutron cross section of 78 naturally-occurring elements and 14 separated isotopes for $2.25 \geq E_n \geq 15.0$ MeV was completed. Data reduction was completed and the results are ready for analysis, publication, and distribution. (auth)

11873 (GA-8085) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period Ending June 30, 1967. Beyster, J. R.; Antunez, H. M.; Borgonovi, G. M.; (and others) (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 10, 1967. Contract AT(04-3)-167. 107p. Dep. CFSTI.

URANIUM-238 — neutron spectra in, thermal, (E/T)
BERYLLIUM — neutron spectra in, thermal, (E/T)
NEUTRONS, THERMAL — spectra in biphenyl, (E/T)
BENZENE — neutron scattering and transmission in, (E/T)
ZIRCONIUM HYDRIDES — neutron angular scattering by, at elevated temperatures, (E/T)
BIPHENYL — neutron scattering by, (T)
PHONONS — dispersion curves for, in beryllium and diamond, (T) (S.F.L.)

11874 (JUL-463-NP) JAHRESBERICHT 1966 DES INSTITUTS FUER NEUTRONENPHYSIK. (Annual Report, 1966, Institute for Neutron Physics). (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik). Mar. 1967. 48p. (In German). Dep.

The activity of the Institute was concentrated on the construction and putting into operation of the beam tube experiment at the FRJ-2 Reactor. With respect to this a large number of experiments were carried out on the three neutron spectrometers (triaxial spectrometer, chopper spectrometer, and rotating crystal spectrometer), the focusing small-angle scattering apparatus, and the mass separator. Graphical data are presented on the small-angle scattering on polycrystalline copper as a function of the grain size, small-angle scattering on polycrystalline copper at large angles as a function of the grain size, angular distribution of the scattering intensity on deformed copper, angular dependence of the Doppel-Bragg scattering for various degrees of deformation, dependence of the Doppel-Bragg scattering on the grain size, intensity distribution in the focus of the neutron mirror, critical scattering on nickel for various pulses, time-of-flight spectra of solid crystalline and amorphous Se, liquid Se, and solid Te for various temperatures and different scattering angles, resolution of elastically scattered neutrons with a rotating crystal, broadening of the quasielastic line as a function of χ^2, mean amplitude-square $\langle x^2 \rangle$ of the H atom in $C_{10}H_{16}$ as a function of temperature, time-of-flight spectra of neutrons scattered under 56° in hydrated polystyrene sulfonic acid, lattice spectra for solid wave vector g, energy spectra $\phi(z,E)$ (z = distance of the cadmium plate) using the Nelkin nucleus, activation ratio of Cd discs, residual ionization of light and heavy fission products in various gases, β-coincident γ spectra of fission products, β-n coincidence rates as function of the B.ρ value, primary charge distribution in the fission of ^{235}U, and counting rate as a function of the mean number of reflections to the determination of the reflectivity of glass. (J.S.R.)

11875 (LA-3823) CALCULATION OF THERMAL NEUTRON SCATTERING CROSS SECTIONS FOR CRYSTALLINE MATERIALS: THE TOR PROGRAM. Clendenin, W. W. (Los Alamos Scientific Lab., N. Mex.). Oct. 20, 1967. Contract W-7405-eng-36. 42p. Dep. CFSTI.

The FORTRAN-IV program TOR has been developed for the calculation of thermal neutron differential scattering cross sections of crystalline materials. The scattering law is calculated in the incoherent approximation by direct evaluation of the Fourier integrals. A new numerical integration technique of improved accuracy is used. This includes a verification based on the detailed balance condition for each value of the scattering law. A two-parameter function, derived from the scattering law but having more accurate interpolation properties, is provided as card output. The latter has the form of input for the FORTRAN-IV program GLEN which obtains the total scattering cross section, thermal neutron diffusion length, and flux-weighted group cross sections. (auth)

11876 (WAPD-TM-518) SUMOR: A FORTRAN-IV PROGRAM FOR THE PHILCO-2000 FOR NEUTRON RESONANCE CROSS SECTIONS INCLUDING LEVEL-LEVEL INTERFERENCE AND EXACT DOPPLER BROADENING. Harris, D. R.; Noll, C. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT-11-1-GEN-14. 33p. Dep. CFSTI.

The program SUMOR, a FORTRAN-IV program for the Philco 2000 for calculation of s-wave neutron scattering and radiative capture cross sections using Reich and Moore resonance formulas; Feshbach, Porter and Weisskopf resonance formulas; and sums of single level formulas, is described. Cross sections are Doppler broadened exactly for target nuclei in Maxwellian motion. Calculated cross sections or calculated cross sections multiplied by reciprocal neutron energy are integrated between arbitrary energy limits. (auth)

11877 ELEMENTARY SOLUTIONS OF THE MONOENERGETIC BOLTZMANN EQUATION IN SPHERICAL GEOMETRY. Nonnenmacher, Th. F. (Univ. Fridericiana, Karlsruhe, Ger.). Nukleonik, 10: 275-7(Nov. 1967).

Elementary solutions of the monoenergetic Boltzmann equation for isotropic neutron scattering in media with spherical geometry are presented. Eigenfunctions belonging to the Case-spectrum, which are regular at the ($\rho = 0$) origin are stated in a form valid for all distances ρ from the origin. Some interesting properties of these eigenfunctions are discussed. For large distances ρ in a medium with spherical geometry a complete set of eigendistributions is found by summing up the spherical harmonics solutions for the sphere. These eigenfunctions show essentially the same properties as the plane-geometrical eigenfunctions given by K. M. Case. (auth)

11878 AGE AND FAST EFFECT IN DEUTERIUM AND DEUTERIUM OXIDE FOR FISSION AND MONOENERGETIC SOURCES. Perkins, S. T. (Univ. of California, Livermore). Contract W-7405-eng-48. Nukleonik, 10: 259-64(Nov. 1967). (UCRL-70504).

A 66 group solution of the second moments equations is utilized to calculate the age and fast effect for neutrons in D and D_2O. Good agreement with the experimental age for fission neutrons as well as the small fast effect from the D(n,2n) reaction indicates that the slowing down properties of D_2O are adequately known for reactor neutronics analysis. Inclusion of all nonelastic events, exactly describing the energy degradation, and preserving the energy-angle correlation for all reactions has justified extending the analysis to higher source energies. (auth)

11879 SPACE, TIME, AND ENERGY SEPARABILITY IN THE PULSED NEUTRON EXPERIMENT. Williams, M. M. R. (London Univ.). Nukleonik, 10: 252-6(Nov. 1967).

By considering the pulse problem in slab geometry, and using a separable kernel, it is demonstrated that when the fundamental decay constant ceases to exist, the concept of buckling also breaks down. Under these conditions, the energy, time, and space coordinates are no longer separable, and not only does the energy spectrum change with time but so also does the spatial distribution of the flux. It is suggested that when the nature of the scattering process makes it possible to define a pseudo-exponential decay, then a pseudo-buckling may simultaneously be defined which is uniquely related to the effective decay constant. (auth)

11880 GEGENBAUER POLYNOMIAL SOLUTIONS OF THE BOLTZMANN EQUATION FOR PLANE AND CYLINDRICAL GEOMETRY. vor der Brueck, H.; Mitthof, E. F.; Nonnenmacher, Th. F. (Univ. Fridericiana, Karlsruhe, Ger.). Nukleonik, 10: 242-52(Nov. 1967).

The Jacobi polynomial method developed in previous papers and used there for solving transport problems in plane geometry with isotropic neutron scattering is investigated and generalized to anisotropic scattering problems in plane geometry. The results obtained in low-order approximations are compared with the exact ones of some test problems in order to get a criterion for the validity of the Jacobi polynomial approximations. It is found

that also for a linear anisotropic scattering law all Gegenbauer polynomial systems defined by a parameter $-1 < \delta < 0$ lead to more accurate results for monoenergetic transport problems in strong absorbing media than the Legendre polynomials in the same order of approximation. Further, a Gegenbauer polynomial solution is constructed which is regular at the origin for the cylinder, if isotropic scattering is assumed. The mathematical procedure connected with this polynomial method is sketched and compared with the usual Legendre polynomial mechanism. In the Appendix some new and important formulas are given. (auth)

11881 QUALITATIVE BEHAVIOR OF TIME-DEPENDENT NEUTRON THERMALIZATION WITHIN THE FRAMEWORK OF A "SECONDARY MODEL". Rietschel, Hermann (Univ. Fridericiana, Karlsruhe, Ger.). Nukleonik, 10: 239-42(Nov. 1967). (In German).

In investigating problems of time dependent neutron thermalization, the time eigenvalue spectrum is of great interest. The λ-spectrum of a "secondary model" is investigated qualitatively. Special investigations of this kind have been done by Corngold for hydrogen and by Williams for a monoatomic gas. It is shown in general, that also for solids and fluids a "secondary model" can be adapted in such a manner that the qualitative behavior of the time eigenvalue spectrum is reproduced exactly. (auth)

11882 EFFECTS OF VOIDS ON DIFFUSION LENGTH AND STREAMING OF NEUTRONS IN WATER. Khan, Naeem Ahmad; Kabir, S. M. (Atomic Energy Centre, Lahore). Nucl. Sci. Eng., 31: 148-9(Jan. 1968).

An attempt was made to measure the diffusion length and streaming factors of neutrons in light water as a function of the percentage of stationary voids. The results were compared with the theoretical predictions of Benoist (AERE-Trans-842(1959)). (D.C.W.)

11883 SEMIANALYTICAL METHODS FOR NEUTRON TRANSPORT THEORY IN PLANE GEOMETRY. Buenemann, D.; Mueller, A. (Institut fuer Reaktorphysik der GKSS, Geesthacht, Ger.). Atomkernenergie, 13: 1-7(Jan.-Feb. 1968).

Two semianalytical methods for solving the Boltzmann equation for stationary multilayer problems in plane geometry are considered. In the first method a general solution is deduced by means of step functions and a Fourier transformation. Special cases are treated as example. The second method gives a multigroup approach for the numerical solution by means of the well-known eigenfunction expansion of Lafore and Millot and of Case. (auth)

11884 ON THE CONNECTION BETWEEN ABSORPTION AND THE ANISOTROPY OF SCATTERING IN NEUTRON TRANSPORT THEORY. Usseli, A. I.; Zweifel, P. F. (Middle East Tech. Univ., Ankara). Nucl. Sci. Eng., 31: 173(1968).

It is shown that a theorem (İNÖNÜ and USSELI, Nucl. Sci. Eng., 23: 251(1965)) which permits one to determine immediately the magnitude of the effect a given anisotropy will produce on the asymptotic flux does not appear to hold for half-space problems. (D.C.W.)

11885 AGE MEASUREMENTS IN ThO_2–D_2O–H_2O LATTICES. Roberts, Donald M.; Pettus, William G. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. Sci. Eng., 31: 49-56(1968).

The ages of the indium 1.46-eV resonance, of "point source" ^{235}U thermal fission neutrons in mixtures of ThO_2–D_2O–H_2O were measured in a lattice in which the volume ratio of moderator-to-aluminum-clad thoria pellets was 1.00 and the square pitch was 0.548 in. The results are given. Within the experimental uncertainty, no difference was found between measurements made parallel rather than perpendicular to the thoria axis, nor were differences found when the detector foils were located inside the aluminum tubes among the pellets rather than in the moderator surrounding the tubes. However, it was found that the size and composition of the stringer which held and positioned the foils in the moderator could perturb the results. Analysis indicated that corrections ranging from +0.4% for 0% D_2O to −0.4% for 90% D_2O arise from considerations of absorption in other than the main indium resonance, detector foil shielding, and the lattice discontinuity required for source irradiation. (auth)

11886 NEUTRON GENERATOR WITH A SELF-TARGET USING D–T REACTIONS. Hara, Eiichi (Hitachi Central Research Lab., Tokyo). Jap. J. Appl. Phys., 7: 70-80(Jan. 1968).

A mixture of deuterium and tritium ions from a high-yield modified duoplasmatron-type ion source was accelerated up to 200 keV, and the yield of 14-MeV neutrons on a stainless steel target with a galvanized Ni layer, on which Ti was evaporated, was measured. The neutron yield per unit current obtained by this method was lower by a factor of about 15 than that obtained by accelerating a D^+ beam on a tritium impregnated target, but because there was no limitation on the beam current, imposed by the life of targets, a neutron yield of 2×10^{11} n/s was obtained. Since the neutron yield at this energy range varies as fourth power of the accelerating voltage, it can be expected to yield many more neutrons for higher accelerating voltages. (auth)

11887 NEUTRON THERMALIZATION IN HEAVY GAS WITH NONUNIFORM TEMPERATURE DISTRIBUTION. Jauho, Pekka; Virjo, Antti (Technical Univ., Helsinki). Nucl. Sci. Eng., 31: 102-9(1968).

A nonabsorbing heavy-gas model is used to study neutron thermalization in a moderator with a nonuniform temperature distribution. The method of Williams is first extended to arbitrary temperature distributions. The method is then applied to spherical geometry, and numerical results are given for the mean energy of the neutrons. In the case where the radius of curvature of the temperature discontinuity is of the same order of magnitude as the rethermalization length, new transport-theoretical corrections are required to diffusion-theoretical results. In plane geometry, the P_3 approximation is used to solve the Boltzmann equation, and the mean energy of neutrons is calculated. The results are compared with diffusion-theoretical and exact calculations, and agreement with the latter is found to be very satisfactory. Some neutron spectra are also plotted in the P_3 approximation. 12 references. (auth)

11888 POLARIZATION OF THERMAL NEUTRONS. Khrushchev, B. I.; Shadmanov, R. Sh. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk UzSSR, No. 9, 36-8(1966). (In Russian).

The optimum conditions for polarizing thermal neutrons were determined by passing the beam through a magnetized ferromagnetic block. The effective scattering cross section in magnetized iron depends on the direction of the spin of neutrons with respect to the magnetic field; the difference between the longitudinal and transverse measurements causes the depolarization of the already polarized beam. The conditions studied included the effect of the cold work and the thickness of the iron and the field strength of the magnetic field. A 20-cm thick beryllium filter was used to collimate the beam, determining the neutron beam intensity by the activation of an indium foil. The results indicated that the largest effect is obtained for a single passage through the 3-cm-thick block when the direction of the cold work is parallel with the direction of the field under conditions of saturation; in this case the polarization amounted to 62%. Deviation from earlier data may be due to the use of the beryllium filter, resulting in a "colder" spectrum. (TTT)

11889 PSEUDOEXPONENTIAL DECAY OF NEUTRON PULSES IN AN INFINITE HOMOGENEOUS ABSORBING MEDIUM. von Baltz, Ralph (Univ. Kridericiana, Karlsruhe, Ger.). Nukleonik, 10: 236-9(Nov. 1967). (In German).

The method of singular eigenfunctions is used to solve the time and energy dependent infinite medium problem. The thermalization kernel is a degenerate one whose zeroth moment is asymptotically correct. We find that we can completely describe the manner in which the neutron density approaches its thermal equilibrium value by means of the continuous spectrum of the Boltzmann operator. The effective relaxation constant of this "pseudo-exponential" decay agrees well with the thermalization constant of a corresponding "primary model" in which the Boltzmann operator has only discrete eigenvalues. (auth)

11890 THERMAL NEUTRON FLUX DISTRIBUTIONS IN A WATER SYSTEM WITH AN INTERNAL CAVITY. Nelson, George William. Cleveland, Case Inst. of Tech., 1966. 129p. Thesis.

Thermal neutron flux distributions in a spherical cavity containing neutron-absorbing BF_3 gas and moderated externally by water were calculated by multigroup diffusion theory, multigroup S_n theory, and a combination of age theory for the moderator and an integral method for the cavity. The calculated thermal fluxes have nearly the same shape as experimental fluxes in single sphere systems and in the moderator and void regions of systems with the BF_3 gas compressed into smaller internal spheres. Inside the internal spheres, where calculated S_n and age fluxes do not agree with experiment, it is suspected that the experimental fluxes are in error. Contrary to the findings of investigators of other cavity systems, the flux distributions and neutron absorption calculated by S_n and diffusion theory were found to be quite different. It is concluded that diffusion theory is inadequate for systems with internal cavities. A 26-group section set including nine upscattering thermal energy groups was used for the multigroup calculations. A considerable change in thermal neutron spectrum was found in the absorbing gas, and thus the use of multigroup cross section sets with one thermal group is not justified unless the spectrum is known in advance. (Disser. Abstr.)

11891 POSITION DEPENDENT NEUTRON SPECTRA IN A MULTIPLYING MEDIUM. Cerbone, Ralph John. Troy, N. Y., Rensselaer Polytechnic Inst., 1967. 226p. Thesis.

Position-dependent thermal spectra were measured in a paraffin-moderated multiplying assembly. Two independent methods were used to obtain the spectrum at the center, surface, and eight positions symmetrical about the center plane in a 6 × 20 × 20 inch assembly. Steady state spectra were obtained with the time of flight technique employing a 24.40 meter flight path in conjunction with the Rensselaer Polytechnic Institute linear accelerator; asymptotic (in time) spectra were obtained with the pulsed-linac chopper technique. A monitoring technique with a tracking reliability of ±1.5 percent was developed. The question of reentrant hole perturbation has been unequivocally answered for this particular research. No perturbation on either the intensity or spectral shape was observed for the holes studied; measurement of the correct extrapolation length in the moderator assembly and calculations performed by McGirt confirm this result. The moderator assembly is identical to the multiplying assembly except that it contains no fuel. The measured spectra are compared to a series of transport calculations using the TET (Thermal Energy Transport) code and DTF IV, the Los Alamos Scientific Laboratory DSN code. It is demonstrated that the DTF IV code with the added anisotropic source option can be used to calculate thermal spectra to within 3%. The scattering matrix may be supplied in either a discrete or multigroup representation. DTF IV calculations are performed with two polyethylene kernels, the Goldman kernel and the Koppel-Young kernel. The experimental data are generally in closer agreement (5% or better) with calculations using the Goldman kernel than the Koppel-Young kernel. This result is also consistent with the measurements of Armstrong on the total cross section of polyethylene. A transport representation of the P_0 component of the spatial source distribution is required to predict the surface spectrum to within 5%. The effect of extrapolating an internal flux shape out to the surface of the assembly results in a calculated intensity which is low by 15%; omission of the P_1 component of the source results in an additional 10% decrease. The Honeck approximation is shown to be adequate where the higher order (greater than P1) effects can be neglected. The spectrum calculations near the surface are sensitive to P1 scattering effects. Omitting the P1 component of the scattering matrix has a 35% effect on the surface spectrum. The spectra are shown to be nowhere sensitive to angular effects beyond P1; a P_3 TET calculation yields the same spectrum as a P1 TET. In order to calculate the surface spectrum to within 5%, materials adjacent to the surface must be properly represented in the calculation. Isotropic scattering from the aluminum structual wall has a 20% effect on the epicadmium directional flux. The B_4C shield must be explicitly treated in the decay constant calculation; fast neutron reflection from the B_4C has a 10% effect on the decay constant. At each position, the asymptotic spectrum calculations with the Goldman kernel are generally in better agreement with measurement than their respective steady state calculation. This may be attributed in part to a slight asymmetry in the steady state source distribution. In the asymptotic measurements where one waits for a fundamental mode to be established, the source distribution is symmetrical. (Disser. Abstr.)

11892 NEUTRON THERMALIZATION IN WATER USING SPHERICAL GEOMETRY. **Nassar, Mohamed Shawky Fahim.** Ames, Iowa, Iowa State Univ. of Science and Tech., 1967. 162p.
Thesis.

A study of neutron thermalization in a sphere of light water was carried out both theoretically and experimentally. The theoretical aspect of the problem was dealt with utilizing the P_1-L_1 approximation. The study employed values of the thermalization parameter, M_2, corresponding to the scattering kernels of Mass-1, Mass-18, Brown & St. John, and Nelkin. When the time decay constant, λ, was plotted versus the spherical Bessel function variable, B^2, two limiting values of B^2 were obtained. One was $B^2_{1,max}$, below which all decay constants were real and one was $B^2_{2,max}$, beyond which no real decay constants existed. The curve describing the fundamental time eigenvalue in the (λ,B^2) plane had a negative curvature at the origin for all values of M_2 investigated. The amplitude of the curvature increased with decreasing value of M_2. For Nelkin's water, the curvature was in agreement with the experimental results. The sensitivity to M_2 was also observed in the limiting value, λ_{lim}, of the fundamental decay constant obtained graphically from the (λ,B^2) plots. The "buckling dependence" of the diffusion cooling coefficient in the P_1 approximation was suppressed by expanding the fundamental time eigenvalue in power series of B^2_T, a slowly varying function of B^2. The difference between B^2_T and B^2 was correlated to the difference between the P_1 and the diffusion approximation in the time dependent case. The thermalization time constant, t_{th}, was evaluated as a function of M_2 for both the energy dependent and the constant mean transport free path. Using Nelkin's water a value for t_{th} of 4.16 μsec was obtained for the energy dependent case. Calculations in the P_1-L_1 approximation were performed in order to determine the form of neutron flux, the diffusion cooled neutron spectra, the criterion for the space-energy separability and the extrapolation length, as a function of buckling. It was demonstrated that, by using the Marshak's boundary condition, the P_1 approximation over-estimates the extrapolation distance of a sphere as compared to that of an "equivalent" slab geometry. The decay constant for nine spheres, with a buckling range of 0.0351-0.6553 cm^{-2}, were determined experimentally. The data were fitted to both functions: $\lambda = f(B^2_g)$ and $\lambda = f(B^2_T)$, where B^2_g is the geometric buckling and B^2_T is the corresponding "transport" buckling. The two fits gave values of the absorption cross section and the diffusion coefficient, D_0, comparable to those previously reported. The value of the diffusion cooling coefficient, C, obtained from the second fit had an improved standard deviation relative to that of the first fit. The extrapolation distances for five geometries, with B^2_g varying between 0.0349 and 0.151 cm^{-2} were obtained for the pulsed neutron experiments by a least squares fit to more than one harmonic. Values of the extrapolation distances were found to lie between 0.392 and 0.338 cm for the indicated range of buckling. (Disser. Abstr.)

11893 TEMPERATURE DEPENDENCE OF THE COHERENT SCATTERING AMPLITUDE FOR FORWARD SCATTERED NEUTRONS. **Edwards, Thomas Reinach.** Buffalo, N. Y., State Univ. of New York, 1967. 86p.
Thesis.

This investigation was concerned with the coherent scattering amplitude as a function of temperature for Pb and Bi and the properties of a reflection spectrometer. The impetus behind such a temperature dependent investigation was the unexplained curvature in the transmission cross section beyond the Bragg cut-off for Pb and Bi as seen in the literature and preliminary data indicating temperature modulation of a neutron beam being scattered in the forward direction off Bi mirrors. This type effect can best be described as a phonon-neutron interaction potential in contrast to the Fermi nuclear potential. The parameter most sensitive to such a potential is the coherent scattering amplitude. Therefore a reflection spectrometer was built and calibrated. This instrument was used as it represents the most fundamental approach towards measuring scattering amplitudes. The amplitudes were determined by measuring the critical angle for total reflection over a range in wavelengths from 1 to 10Å. The spectrometer was calibrated to a 1.69% resolution in energy using the Bragg peaks in the transmission cross section for polycrystalline iron and lead and to a 10% accuracy in scattering amplitudes using the coherent amplitude for Al. Aluminum is a good 1/v material in its transmission cross section beyond its Bragg cut-off. For comparison with the effect sought after in Pb and Bi, the temperature dependence in the scattering amplitude for Al was measured. The temperatures considered were room temperature, dry ice (193°K), and liquid nitrogen (77°K). This investigation has lead to what appears to be the discovery of a new effect in the coherent scattering amplitude. The effect is a temperature dependent phonon-neutron interaction for forward scattered neutrons in contrast to the Fermi potential and with a negative sense. The data obtained for Bi and Pb does seem to indicate a small but nevertheless observable change in the amplitude with temperature. The magnitude of the interaction is second order compared to the strength of the Fermi nuclear potential. The largest effect occurs in Bi between room temperature and dry ice where the amplitude changes 11.5%. The negative behavior of this interaction is explained by the fact that the scattering amplitude increases as the temperature decreases whereas in the usual case temperature effects tend to disappear as the temperature is lowered. The largest effect for lead shows a smaller change, the amplitude increases by just 0.38 fm between dry ice and liquid nitrogen. To further substantiate this effect, a spectrometer of higher resolution in scattering amplitudes must be built. Also, amplitudes measured over a wider temperature range must be considered. (Disser. Abstr.)

11894 EXPERIMENTAL DETERMINATION OF THERMAL AND NEUTRON DIFFUSION PARAMETERS BY THE USE OF EMPIRICAL FUNCTIONS. **Adams, Cyrus Hall.** Urbana, Ill., Univ. of Illinois, 1967. 96p.
Thesis.

A method is developed to measure diffusion equation parameters in a variety of situations. Data (temperature or neutron flux) at a number of locations and times are employed to construct polynomial approximations to the observed phenomenon. Derivatives appearing in the differential equations are evaluated from the approximating functions and are then used to determine the parameters in the equations. Summation orthogonal polynomials are used in constructing the empirical functions. These proved effective in avoiding problems associated with the usual least-squares fitting calculations. If readings were taken of the differences (not absolute values) of the observed quantity, it was found that the functions

could be made closer approximations. Three examples are included. The first is a measurement of the thermal diffusivity of copper. A simple experimental design is shown to give results over a range of 100°C which agree with the literature to within 3%. The second is an investigation of the space dependence of the heat generation due to nuclear radiation in a metal cylinder in the University of Illinois TRIGA reactor. This is a unique application of the technique. Finally the analysis of a neutron diffusion experiment is included to show how this method might be applied in other fields. (Disser. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstract 11667.

11895 POSSIBILITY OF INCREASING THE PRECISION OF THE n–d ELASTIC SCATTERING PHASE ANALYSIS. Myachkova, S. A.; Efimov, V. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 307-9(Feb. 1967). (In Russian).

On the basis of an analysis of literature data, the possibility is pointed out of more accurate phase analysis of n–d scattering in experiments involving scattering of polarized neutrons on unpolarized deuterons. The experimental techniques suggested include analysis of the elastic scattering of neutrons polarized in the $^{7}Li(p,n)^{7}Be$ reaction on ^{4}He or the resonance scattering on ^{24}Mg. It is concluded that the method will enable determination of which of the given phase sets is true. (JPRS)

11896 MEASUREMENT OF THE TRITIUM NEUTRON CROSS SECTION IN THE ENERGY RANGE 0.007 TO 5 eV. Vertebnyi, V. P.; Vlasov, M. F.; Kirilyuk, A. L.; Kolotyi, V. V.; Pasechnik, M. V.; Stepanenko, V. A. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 349-52(Feb. 1967). (In Russian).

$Zr^{3}H_{2}$ was used to measure the neutron total and scattering cross-sections to determine the energy dependence in the range 0.007 to 5 eV in a study of the bound state of ^{4}H. The data obtained do not indicate the existence of ^{4}H bound state. The ^{3}He formed in the course of tritium decay remains bound in the $Zr^{3}H_{2}$ lattice to the extent of 2.5%. (JPRS)

11897 PROPOSED EXPERIMENTAL TEST ON THE ELEMENTARY PARTICLE TREATMENT OF COMPLEX NUCLEI. Grismore, R. (Lehigh Univ., Bethlehem, Pa). Nucl. Phys., A108: 1-5(1968).

A suggested experiment is described for measurement of the absolute differential cross section for $n + {}^{3}_{2}He \rightarrow p + {}^{3}_{1}H$ at forward angles and medium energies. The purpose is to test the theory of Kim and Primakoff which treats complex nuclei as "elementary particles." (auth)

11898 MEASUREMENTS OF THE CORRELATION PARAMETER C_{NN} IN PROTON–PROTON SCATTERING. Jarvis, O. N. (Atomic Energy Research Establishment, Harwell, Eng.); Brogden, T. W. P.; Rose, B.; Scanlon, J. P.; Orchard-Webb, J.; Wigan, M. R. Nucl. Phys., A108: 63-80(1968).

The spin-correlation parameter C_{NN} in proton-proton scattering was determined for the scattering angle 90° cms at the three energies 143.2, 98.0, and 73.5 MeV. The value of C_{NN} (61.8°) was also determined at 143.2 MeV. The results are expressed (where appropriate) as ratios to the C_{NN} (90°) value at 143.2 MeV. The experimental technique involved a polarized proton beam and a polarized proton target. The radiation damage of the proton target constituted a serious problem in this work. (auth)

11899 SMALL-ANGLE BEHAVIOR OF THE POLARIZATION IN p–d ELASTIC SCATTERING. McKee, J. S. C.; Luccio, A. U.; Slobodrian, R. J.; Tivol, W. F. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Phys., A108: 177-9(1968). (UCRL-17755).

Measurements of the polarization in p-d scattering at 11.6 MeV show a minimum in the asymmetry distribution at 29° cms. This observation seems to be consistent with spin-orbit effects in the p-d interaction at this energy. (auth)

11900 ELASTIC ELECTRON SCATTERING ON ^{4}He AT ENERGIES BETWEEN 30 AND 59 MeV. Erich, U.; Frank, H.; Haas, D.; Prange, H. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 209: 208-18(1968). (In German).

The cross section of ^{4}He for elastic electron scattering was measured relative to that of the proton using a gas target with helium, hydrogen, or a mixture of both gases. Scattering angles were between 56 and 130°, and the energy was varied from 30 to 59 MeV. A model-independent rms charge radius of 1.63 ± 0.04 fm was evaluated for the α particle. (auth)

11901 ALPHA-PARTICLE WAVE FUNCTIONS. Beam, John Edgar. Madison, Wis., Univ. of Wisconsin, 1966. 115p. Thesis.

A detailed discussion is given of the construction of four-nucleon wave functions, with emphasis on those having the quantum numbers of the alpha-particle ground state. A function is characterized by its transformation properties under rotations, and permutations of particle coordinates. States consistent with the alpha-particle quantum numbers are positive-parity, isospin-zero $^{1}S_{0}$, $^{3}P_{0}$, and $^{5}D_{0}$ states. The ground state, predominantly $^{1}S_{0}$, is a superposition of all three possibilities, since the two-nucleon interaction contains non-central terms. Functions of definite orbital angular momentum are further grouped into equivalence classes of functions ("states"), with grouping by the separate transformation properties under the symmetric group S_{4} of spin, isospin, angular, and space-scalar (internal) parts of the wave functions. Reference to the center of mass is eliminated by use of relative space coordinates. A choice of relative coordinates, different from the customary one, is made which treats each nucleon in an identical fashion, appropriate to a description of charge-independent forces. Because of the closed-shell nature of ^{4}He and the relative simplicity of S_{4}, the classification of alpha-particle states is scarcely more complicated than that of Sachs or Derrick and Blatt for the triton. One finds for the alpha particle three S states, eight P states, and six D states, a result previously obtained by Cohen. However it is shown in this thesis that only five of the six D states are independent; the dependent state is then explicitly eliminated. Further, only the S states are orthogonal in Cohen's classification. The concept of S-independence, a generalization of linear independence introduced by Jezak and Bolsterli for the three-nucleon system, is extended to the four-nucleon system and used to construct a complete set of three S, six P and five D states, all mutually orthogonal. In the orthogonal classification the sixth D state vanishes identically. Although the total number of independent states differs in the orthogonal (14) and the non-orthogonal (16) classifications, the most general superposition of states in each can be written in terms of 32 independent scalar functions. The coupling effects of the tensor and Coulomb interactions are discussed. S-state equations of motion are derived for an arbitrary charge-independent, central two-nucleon interaction; S, P, and D-state equations are solved explicitly for a harmonic oscillator interaction. The construction of states with quantum numbers other than those of the alpha particle is indicated. Spin and isospin matrix elements are evaluated, including those of tensor, spin-orbit, Coulomb, and spin-exchange interactions. The formalism of this thesis is applied, in an appendix, to the shell-model spurious-state problem. Applications of the classification scheme are suggested. (Disser. Abstr.)

11902 DETERMINATION OF THE NEUTRON–NEUTRON SCATTERING LENGTH. Shield, Edward. Berkeley, Calif., University of California, 1967. 71p. Thesis.

Measurements on the reaction $T(d,^{3}He)2n$ at 32.7-MeV incident deuteron energy were used to determine the n-n scattering length. Watson's theory of final-state interactions provides a theory with which the experimental data giving the number of ^{3}He at 6 and 8° vs energy can be compared. Comparison is made with numbers of ^{3}He near the maximum energy in which case the neutrons go off with little relative energy under the influence of a final-state s-wave interaction. The best fit of the data to theory gives $a_{nn} = -16.1 \pm 0.1$°F. The applicability of this method is proved by measurements on the reaction $^{3}He(d,t)2p$ which give a value for a_{pp} equal to the accepted value within the experimental errors. Comparisons of results with other measurements of a_{nn} are given. (Disser. Abstr.)

11903 FINAL-STATE INTERACTIONS IN THE $^{2}H(p,pn)p$ REACTION. Jackson, William Roy Jr. Houston, Tex., Rice Univ., 1967. 155p. Thesis.

The $^{2}H(p,pn)p$ reaction was studied at a bombarding energy of 9.0 MeV and several coincidence detection angles using the Rice University Tandem Van de Graaff accelerator and computer-analyzer system. The energies of the detected coincident particles were determined using a solid-state surface-barrier detector for the proton and time-of-flight measurement on the neutron. The data are discussed with regard to the observed final-state interactions and the generalized density of states. Evidence is seen for a neutron-proton final-state interaction corresponding to an interaction energy from slightly more than zero to about 75 keV; however, no evidence is found for a proton-proton final-state interaction. (Disser. Abstr.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 10553, 11667, 11755, 11922, 11944, and 11950.

11904 MEASUREMENT OF PROTON SCATTERING ASYMMETRY IN THE $^{9}Be(d,p)^{10}Be$ REACTION WITH POLARIZED DEUTERONS. Saltykov, L. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 323-6(Feb. 1967). (In Russian).

The proton asymmetry was measured in the $^{9}Be(d,p)^{10}Be$ stripping reaction to study the effect of the spin-orbital terms in interaction potentials. Polarized deuterons were obtained by elastic scattering of deuterons on a carbon target at 13.8 MeV. Asymmetry could be measured simultaneously at various angles. The form of angular cross-section distribution of the reaction and the angular dependence of proton polarization do not change appreciably in the range 8 to 13 MeV. No correlation between the angular dependence of asymmetry and polarization is observed at angles greater than 40°. Asymmetry sign change occurs at 50°. (JPRS)

11905 INVESTIGATION OF THE $^{9}Be + t \rightarrow n + t + {}^{8}Be$ REACTION. Serov, V. I.; Abramovich, S. N.; Pereshivkin, V. A.; Morkin, L. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 333-5(Feb. 1967). (In Russian).

Most available results of the stability of ^{4}H derive from experiments at high energy in which the resonance interaction is not noticeable. The data obtained from the $^{9}Be(t,nt)^{8}Be$ reaction indicate that the possible value of the triton–neutron resonance interaction energy lies in the range $(0.2 < \epsilon_0(nt) < 0.5)$ MeV. It is also concluded that no resonance interaction exists at $(1 < \epsilon(nt) < 200)$ keV. (JPRS)

11906 ROTATIONAL STATES IN ^{20}Ne EXCITED BY THE REACTION $^{16}O(^{7}Li,t)$. Middleton, R.; Rosner, B.; Pullen, D. J.; Polsky, L. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 20: 118-20(Jan. 15, 1968).

The reaction $^{16}O(^{7}Li,t)^{20}Ne$ was studied at 16-MeV incident energy. The reaction is found to proceed essentially by a direct mechanism, exciting only those rotational bands in ^{20}Ne which are allowed by the selection rules in the SU(3) scheme. (auth)

11907 A SHELL-MODEL CALCULATION OF ^{18}F AND ^{18}O USING THE TABAKIN INTERACTION. Clement, David M.; Baranger, Elizabeth Urey (Univ. of Pittsburgh). Nucl. Phys., A108: 27-48(1968).

A shell-model calculation of ^{18}F and ^{18}O is performed in which the Tabakin interaction is used as the residual shell-model interaction. Two kinds of second-order corrections are included by perturbation theory. In one (the second Born corrections), plane wave intermediate states are used; in the other, particle-hole core-excited states are included. The results agree quite well with experiment. A detailed comparison is made between the results of this calculation and that made by Kuo and Brown with the Hamada-Johnston hard-core potential. The matrix elements of the two potentials agree surprisingly well. The second Born corrections are important in improving the agreement between the two sets of T = 0 matrix elements. (auth)

11908 A SHELL-MODEL STUDY OF THE ISOTOPES OF O, F, AND Ne. Arima, A.; Cohen, S.; Lawson, R. D.; Macfarlane, M. H. (Argonne National Lab., Ill.). Nucl. Phys., A108: 94-112(1968).

The nuclei $^{18,19,20}O$, $^{18,19,20}F$, and ^{20}Ne are described in terms of the shell model within the configurations $(1d_{\frac{5}{2}}, 2s_{\frac{1}{2}})^{n}$, n = 2 to 4. The residual nucleon-nucleon interaction is parametrized in terms of its two-body matrix elements, which are varied until a best fit to the spectra is obtained. The resulting wave functions are used to compute static and dynamic nuclear properties. In general, the model fits the known experimental data on spectra, transition rates and static multipole moments quite satisfactorily. In particular, good agreement with experiment is obtained for the rotational spectrum of ^{20}Ne and for the lifetimes of several of the states of its ground-state rotational band. Fitting the level properties of ^{20}Ne, however, is found to impose on the interaction parameters few restrictions beyond those already implied by a successful treatment of the O and F spectra. Although 36 states are fitted with a 16-parameter potential, it is found that several of the two-body matrix elements are not very well determined. Those interaction parameters that are well determined are compared with the results of a recent reaction-matrix calculation. It is found that satisfactory over-all agreement with experiment can be obtained only if the 1^{+} excited state of ^{18}F at 1.7 MeV is omitted from the fitting procedure. Rough estimates suggest that a core-excited 1^{+} state should occur at about this energy. Thus although the shell model with effective interaction can absorb large amounts of configuration impurity, it cannot do so successfully when the degree of configuration impurity in one of the states under consideration differs radically from that in its neighbors. (auth)

11909 RADIATIVE CAPTURE OF ^{3}He BY ^{7}Li FROM 3 TO 6 MeV. Ling, S. C.; Young, A. M.; Blatt, S. L. (Ohio State Univ., Columbus). Nucl. Phys., A108: 221-32(1968).

The reaction $^{7}Li(^{3}He,\gamma)^{10}B$ was studied in the energy range 3.0 MeV $\leq E_{^{3}He} \leq$ 6.0 MeV, using an anticoincidence-shielded NaI(Tl) gamma-ray detector. Excitation functions for capture radiation to the ground and first four excited states of ^{10}B were measured with the detector at 90° to the incident beam direction. A strong resonance at $E_{^{3}He}$ = 3.40 MeV with a c.m. width of 910 keV was found in the cross section for capture to the 2^{+}(T = 0), 3.59 MeV state of ^{10}B. Angular distribution measurements indicate s-wave capture; the resonant state can be given the spin and parity assignment 1^{-} or 2^{-} (T = 1) with 2^{-} being more likely. The compound-nucleus mechanism appears to dominate the capture process below 6-MeV bombarding energy. (auth)

11910 REACTIONS ON LIGHT ELEMENTS INDUCED BY CHARGED PARTICLES ELASTICALLY SCATTERED BY FAST NEUTRONS. Naude, W. J. (Univ. of Stellenbosch, South Africa); Peisach, M. J. Nucl. Energy, 21: 893-8(Dec. 1967).

Average cross sections for reactions induced by recoil-charged particles, obtained in an irradiating flux of 14.5-MeV neutrons, were measured in boric acid, wax, cyclohexane, NH_4F, NH_4SCN, water, and D_2O. In addition, the cross section for the reaction $^{11}B(n,p)^{11}Be$ induced by 14.5-MeV neutrons was found to be 7.1 ± 2 mb. (auth) (UK)

11911 THE REACTION $^{14}N(d,\alpha)^{12}C$ AT DEUTERON ENERGIES BETWEEN 2.3 AND 5.8 MeV. Boehle, K.; Leifson, J.; Meyer, V.; Mueller, H. H. (Univ., Zurich). Helv. Phys. Acta, 40: 973-80(Dec. 30, 1967). (In German).

Angular distributions for the reactions $^{14}N(d,\alpha_0)^{12}C$ and $^{14}N(d,\alpha_1)^{12}C^{*}$ have been measured at 19 energies between E_d = 2.3 and 5.8 MeV. Excitation curves were obtained between 2 and 3.7 MeV at ϑ_{Lab} = 90° for elastically scattered deuterons, three α-particle groups, and for seven proton groups leading to excited states of ^{15}N. Absolute cross sections are given and are compared with results from other laboratories. (auth)

11912 MEASUREMENT OF TOTAL CROSS SECTIONS FOR THE REACTIONS $^{18}O(n,\alpha_0)^{15}C$ AND $^{18}O(n,\alpha_1)$ FOR NEUTRON ENERGIES BETWEEN 7.5 AND 8.6 MeV. Stammbach, Th.; Darden, S. E.; Huber, P.; Sick, I. (Univ., Basel). Helv. Phys. Acta, 40: 915-28(Nov. 15, 1967). (In German).

An ionization chamber filled with 93% ^{18}O was irradiated with neutrons from the $^{9}Be(\alpha,n)^{12}C$ reaction. The total cross sections for the $^{18}O(n,\alpha_0)^{15}C$ and $^{18}O(n,\alpha_1)^{15}C^{*}$ (0.75 MeV) reactions were measured for neutron energies between 7.5 and 8.6 MeV. Two resonances are found at E_n = 7.70 ± 0.05 MeV and E_n = 8.05 ± 0.05 MeV with Γ = 0.25 and 0.35 MeV, respectively. For an absolute determination of the neutron flux protons emerging from a thick $(CH_2)_n$ radiator were detected with a CsI scintillator. This method is described in detail and gives the neutron flux with an accuracy better than 1%. To obtain the needed range-energy relation for protons in $(CH_2)_n$, the ranges for E_p = 6.14 and 16.45 MeV were measured permitting the use of computed range curves. (auth)

11913 ISOBARIC SPIN FORBIDDEN AND ALLOWED $^{16}O(d,\alpha)$ ^{14}N REACTIONS. Jobst, Joel Edward. Madison, Wis., University of Wisconsin, 1966. 146p.

Thesis.

A differentially pumped gas scattering chamber with solid-state detectors was used to obtain differential cross sections for the $^{16}O(d,\alpha)$ reaction leaving ^{14}N in its ground state and four lowest excited states. Differential cross sections for these five alpha groups were measured for bombarding energies E_d = 5 to 9 MeV, in 10- to 20-keV steps, at the following cms angles for the first excited state group: θ_{cm} = 30.0, 47.4, 90.3, 135.0, 150.0, and 168.5°. Target thickness was always ≤13 keV. Angular distributions for the ground state and the first and second excited states were obtained at several energies. Differential cross sections in large energy steps were obtained up to E_d = 15 MeV at Φ_{lab} = 14 and 166° with a solid-state counter telescope. The $^{16}O(d,\alpha)$ reaction leaving ^{14}N in its first excited state is inhibited by spin and parity restrictions and is forbidden by isobaric spin conservation. However, weak yields of alphas corresponding to this state were observed with cross sections up to ~2 mb/sr. Angular distributions were taken at several resonances in the excitation curves and compared with theoretical distributions to assign spins and parities to the following levels in the intermediate nucleus, ^{18}F: 4^{+}, 12.49 MeV; 5^{-} 12.65 MeV; 4^{+}, 13.03 MeV;

4^+, 13.30 MeV; (4^+), 13.65 MeV; 3^-, 13.76 MeV; $(4^+,5^-)$, 14.08 MeV. The integrated cross section of the forbidden alpha group was compared with those of the allowed ground and second excited state groups to obtain an estimate of the admixture of different isobaric spin states in the compound nucleus ^{18}F. From excitation energies of 11.9 to 15.5 MeV (E_d = 5 to 9 MeV) the impurity is ~30%; the impurity declines with increasing excitation energy, in agreement with theoretical predictions. Alpha groups corresponding to the ground, the second, third and fourth excited states of ^{14}N exhibit fluctuating differential cross sections; from E_d = 5 to 9 MeV the average values are 5 to 10 mb/sr and the maximum ~30 mb/sr. The statistical theory for fluctuating cross sections recently developed by Ericson and others may not describe very well the ^{18}F excitation region studied in this experiment. Nevertheless, correlation functions for all five groups were calculated to obtain the average level width, Γ, of ^{18}F states. For the first excited state, Γ ~ 70 keV; for the other groups Γ ~ 150 keV. Many higher levels in ^{14}N were observed, including the T = 1 levels at 9.17, 9.508, and 11.23 MeV. No evidence was found for previously reported levels at 6.05, 6.70, 7.40 and 7.60 MeV. (Disser. Abstr.)

11914 EXPERIMENTAL STUDY OF A STELLAR NEUTRON SOURCE; $^{13}C(\alpha,n)^{16}O$. Davids, Cary Nathan. Pasadena, Calif., California Inst. of Tech., 1967. 119p.

Thesis.

Measurements are described which were made of the thick-target neutron yield from the reaction $^{13}C(\alpha,n)^{16}O$. The yield was determined for laboratory bombarding energies between 0.475 and 0.700 MeV, using a stilbene crystal neutron detector and pulse-shape discrimination to eliminate gamma rays. Stellar temperatures between 2.5 and 4.5×10^8 °K are involved in this energy region. From the neutron yield the astrophysical cross-section factor S(E) was extracted which was found to fit a linear function: $S(E) = [(5.48 \pm 1.77) + (12.05 \pm 3.91)E] \times 10^5$ MeV-barns, center-of-mass system. The stellar rate of the $^{13}C(\alpha,n)^{16}O$ reaction is calculated, and is discussed with reference to helium burning and neutron production in the core of a giant star. Results are also presented of measurements carried out on the reaction $^9Be(\alpha,n)^{12}C$, taken with a thin Be target. The bombarding energy-range covered was from 0.340 to 0.680 MeV, with excitation curves for the ground- and first excited-state neutrons being reported. Some angular distributions were also measured. Resonances were found at bombarding energies of E_{LAB} = 0.520 MeV (E_{CM} = 0.360 MeV, Γ ~ 55 keV CM, ωγ = 3.79 eV CM) and E_{LAB} = 0.600 MeV (E_{CM} = 0.415 MeV, Γ < 4 keV CM, ωγ = 0.88 eV CM). The astrophysical rate of the $^9Be(\alpha,n)^{12}C$ reaction due to these resonances is calculated. (Disser. Abstr.)

11915 STUDY OF T = 1, T = ½, AND T = 2 STATES IN SOME LIGHT NUCLEI USING (^{3}He,n) REACTIONS. Adelberger, Eric George. Pasadena, Calif., California Inst. of Tech., 1967. 213p.

Thesis.

The (^{3}He,n) reactions on ^{11}B, ^{15}N, ^{16}O, and ^{18}O targets were studied using a pulsed-beam time-of-flight spectrometer. Special emphasis was placed upon the determination of the excitation energies and properties of states with T = 1 (in ^{19}Ne), T = ½ (in ^{13}N and ^{17}F) and T = 2 (in ^{20}Ne). The identification of the T = ½ and T = 2 levels is based on the structure of these states as revealed by intensities and shapes of angular distributions. The reactions are interpreted in terms of double stripping theory. Angular distributions are compared with plane and distorted wave stripping theories. Results for the four reactions are summarized below: The $^{16}O(^3He,n)$ reaction was studied at incident energies up to 13.5 MeV and two previously unreported levels in ^{19}Ne were observed at $E_x = 4.55 \pm 0.015$ MeV (Γ = 70 ± 30 keV) and $E_x = 5.14 \pm 0.018$ MeV (Γ = 100 ± 40 keV). The $^{11}B(^3He,n)$ reaction was studied at incident energies up to 13.5 MeV. Three T = ½ levels in ^{13}N were identified at $E_x = 15.068 \pm 0.008$ MeV (Γ < 15 keV), $E_x = 18.44 \pm 0.04$, and $E_x = 18.98 \pm 0.02$ MeV (Γ = 40 ± 20 keV). The $^{15}N(^3He,n)$ reaction was studied at incident energies up to 11.88 MeV. T = ½ levels in ^{17}F were identified at $E_x = 11.195 \pm 0.007$ MeV (Γ < 20 keV), $E_x = 12.540 \pm 0.010$ MeV (Γ < 25 keV), and $E_x = 13.059 \pm 0.009$ MeV (Γ < 25 keV). The $^{18}O(^3He,n)$ was studied at incident energies up to 9.0 MeV. The excitation energy of the lowest T = 2 level in ^{20}Ne was found to be 16.730 ± 0.006 MeV (Γ < 20 keV). Angular distributions of the transitions leading to the above higher isospin states are well described by double stripping theory. Analog correspondences are established by comparing the present results with recent studies of (t,p) and (^{3}He,p) reactions on the same targets. (Disser. Abstr.)

11916 APPLICATION OF AN ANTICOINCIDENCE-SHIELDED SCINTILLATION SPECTROMETER TO THE STUDY OF THE $^{14}N(p,\gamma)^{15}O$ REACTION. Evans, Albert Edwin Jr. College Park, Md., Univ. of Maryland, 1965. 182p.

Thesis.

A spectrometer was built for the study of gamma-ray spectra resulting from nuclear reactions. The spectrometer consists of a 5" diameter by 10" long NaI(Tl) detector with 5" photomultiplier, surrounded by a hexagonal anticoincidence array of eighteen 7" diameter by 24" long liquid-scintillation cells. The assembly, shielded with 4" of lead, is mounted on a rotary table for angular distribution studies. In order to enhance the effectiveness of the anticoincidence guard, those pulses from the NaI(Tl) crystal which are coincident with pulses from the anticoincidence guard are stored in the second half of a 512-channel pulse-height analyzer memory, the anticoincident pulses being stored in the first half of this memory. A fraction of the coincident spectrum is subtracted from the anticoincident spectrum in order to compensate for the imperfect efficiency of the anticoincidence guard. The coincident spectrum is multiplied by a function of gamma-ray energy, to take into account the energy dependence of the anticoincidence-shield efficiency before making the subtraction. The spectrometer was demonstrated to be useful for gamma radiation measurements in the energy range from 0.35 to 17.6 MeV. The spectrometer energy resolution is 8.4% for 0.662 MeV gamma rays and 3.2% for 17.64 MeV radiation. The spectrometer was used in the study of the $^{14}N(p,\gamma)^{15}O$ reaction for proton bombarding energies from 0.97 to 1.96 MeV. Branching ratios were obtained for the decays of the 8.29, 8.75, 8.92, and 8.98 MeV levels, and angular distribution measurements were made for the most prominent gamma rays. In addition, the yield of gamma radiation to the ground state of ^{15}O, to the 5.19-5.24 MeV level, to the 6.18 MeV level, to the 6.79 MeV level, and to the 7.55 MeV level was measured as a function of proton bombarding energy. The 8.29 MeV level decays directly to the ground state of ^{15}O 54% of the time, to the 5.24 MeV level 43%, to the 6.16 MeV level 2.2%, and to the 6.86 MeV level 1.2% of the time. A previously reported transition to a level at 7.17 MeV is obscured by oxygen in the target. The 8.75 MeV level exhibits a ⅔ branch to the 5.19 MeV level, with the remainder of the decays proceeding by way of the 6.18 MeV level. The 8.92 MeV level decays to the ground state (21%), to the 5.19 MeV level (23%), to the 6.18 MeV level (30%) and to the 6.86 MeV level (26%). The intensity of the transition to the 5.19 MeV level and the angular distribution of the 8.92 MeV ground-state transition together establish the spin of the 8.92 MeV level as ½. The 8.98 MeV level decays directly to ground 93.4% of the time, the rest of the time through the 5.19 MeV level. The transition to the 5.19 MeV level indicates J ≤ ½ for the 8.98 MeV level. Transitions from the levels at 8.29 and 8.92 MeV to the 6.86 MeV establish J ≤ ½ for the 6.86 MeV level. Since the 6.86 MeV level decays in turn to the 5.24 MeV level, its spin is probably ≥ ½. Off-resonant spectra indicate that the ground-state gamma ray is due partly to the broad $^{14}N(p,\gamma)$ resonance at 2.38 MeV and partly to a non-resonant process. The 6.79 MeV gamma ray is probably due to a direct-capture process. There is evidence for direct capture into the 7.55 MeV level. The question of non-resonant capture into other levels of ^{15}O is not resolved. (Disser. Abstr.)

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Refer also to abstracts 11558, 11908, 11944, 11945, 11949, 11950, 11956, 11966, and 11968.

11917 (AWRE-O-63/67) NEUTRON CROSS SECTION OF COPPER IN THE ENERGY RANGE 0.0001 eV TO 15 MeV. SOURCES OF DATA FOR FILES 249 TO 251 IN THE UKAEA NUCLEAR DATA LIBRARY. Offord, Susan M.; Parker, K. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec. 1967. 77p. Dep. CFSTI. UK 11s, 0d.

The sources of data for files 249 (natural Cu), 250 (^{63}Cu) and 251 (^{65}Cu) added to the UKAEA Nuclear Data Library in June 1967 are described. For natural copper neutron cross sections are based on evaluations by Benzi (CNEN, Bologna) and Häggblom (Ab Atomenergi, Stockholm) with improvements taking into account more recent experimental and theoretical work. For ^{63}Cu and ^{65}Cu, (n,γ), (n,p), (n,α) and (n,2n) cross sections are given in the energy range 1 keV to 15 MeV which are consistent with the data for natural copper. (auth)

11918 (ORNL-TM-2052) NEUTRON ELASTIC AND INELASTIC SCATTERING FROM ^{56}Fe FROM 4.60 TO 7.55 MeV. Kinney, William E. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 124p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Neutron elastic and inelastic scattering cross sections for ^{56}Fe were measured in the energy range from 4.60 to 7.55 MeV by the time-of-flight method in order to study the competition between direct interactions and compound nucleus decay in the

excitation of the 2^+ collective level that has an excitation energy of 0.846 MeV, to test the validity of the statistical model in predicting the cross sections for inelastic scattering to the higher levels, and to obtain optical model parameters from fits to the elastic scattering data. Neutrons were produced by the $^2D(d,n)^3He$ reaction in a deuterium gas cell and had an energy uncertainty of 40 keV. The neutrons were scattered by solid right cylindrical samples of natural iron and were detected in a shielded liquid scintillator optically coupled to a phototube whose output, together with a time reference signal, measured the flight time with a typical time resolution for the elastic neutrons of 3 nsec. Gamma rays were discriminated against to decrease the background, and the neutron production of the target was monitored by a simplified time-of-flight detection system. Measurements were made at angles ranging from 25 to 140° with 3.7- to 5.3-m flight paths. Electronic "walk" was corrected by dividing the range of pulse heights of the detected neutrons into groups, taking a time-of-flight spectrum for each group, and aligning and adding the group spectra. Peak areas were extracted by isolating each peak visually on an oscilloscope screen by means of a light pen operating with a PDP-7 computer program which then computed the area of the isolated peak. The peak areas were combined with detector efficiency measurements, scattering-sample data, and geometric data to produce cross sections which were corrected for finite sample effects by applying factors obtained from a Monte Carlo computer calculation. Optical model minimum χ^2 fits were made to the elastic-scattering data, with the real and imaginary well depths varied to achieve the best fits and the other parameters held constant at standard values. Optical model calculations with average values of 46.6 and 11.8 MeV for the real and imaginary well depths, respectively, were in reasonable agreement with experiment from 4.0- to 7.6-MeV incident neutron energy (E_n). Inelastic scattering cross sections to levels and groups of levels to an excitation energy of 4.728 MeV were measured, and statistical model calculations were in good agreement below an E_n of 5.6 MeV with the measured values. The 2.085- and 2.654-MeV levels were predicted to within 20% up to an E_n of 7.6 MeV but the calculated cross sections for the higher levels were greater by as much as a factor of 2.5 than those measured. On the basis of the agreement below 5.6 MeV, support was given to a previous suggestion of a triplet comprising the group of levels at 3.60-MeV excitation energy, with the spin of the third level having to be greater than zero for a good fit to the data to be achieved. The addition of distorted-wave-Born-approximation and statistical model results gave cross sections that were in good agreement with experiment for inelastic scattering to the 0.846-MeV level. The calculated contribution of direct interactions to the excitation of this level was equal to 21% at 4.0-MeV incident neutron energy, rose linearly with energy to a value of 57% at 6.6 MeV, and reached a value of 66% at 7.6 MeV. (auth)

11919 (PUC-937-264) DEFORMATIONS IN THE CALCIUM REGION. Gerace, William J. (Princeton Univ., N. J. Palmer Physical Lab.). May 1967. Contract AT(30-1)-937. 91p. Dep. CFSTI.

Thesis.

Collective states are admixed with the usual shell-model states in an attempt to construct a model capable of explaining certain properties of nuclei in the Ca region. These properties, which can not be explained by the shell model alone, include anomalously large electromagnetic transition rates and the number of low-lying energy levels. Deformed states are constructed according to an isospin coupling scheme which favors states that have low total isospin but which have particles and holes separately coupled to maximum allowable isospin. Matrix elements are then calculated between these states and shell-model states using two body matrix elements derived from the Hamada-Johnston realistic nucleon–nucleon force. Treating the position of the unperturbed deformed band of states as a parameter, wavefunctions for physical states are obtained. These wavefunctions are then used to predict values for some reduced electromagnetic transition rates and single-particle strengths. These techniques are applied to nuclei in the vicinity of A = 40. Where possible predicted quantities are compared with experimental results. The deformed model shows a definite improvement over a pure shell-model description of these nuclei, however not all properties of these nuclei can be explained. (auth)

11920 STRUCTURE OF THE GROUND-STATE ISOBARIC ANALOG RESONANCE IN ^{45}Sc BY THE REACTION $^{44}Ca(p,n\gamma)^{45}Sc$. Chilosi, G.; Ricci, R. A.; Vingiani, G. B. (Istituto Nazionale di Fisica Nucleare, Naples). Phys. Rev. Lett., 20: 159-60(Jan. 22, 1968).

A fine-resolution study was made of the resonance corresponding to the analog of the ^{44}Ca ground state in the reaction $^{44}Ca(p,n\gamma)^{45}Sc$. The proton beam was provided by the 5.5 MeV Van de Graaff accelerator of the University of Padova. The gamma rays were detected at 55° to the proton beam using a NaI(Tl) scintillation detector and a Ge(Li) crystal detector. The schematic diagram of the reaction and the yield curve of the 780-keV gamma ray over the region of the analog-state resonance taken with a target of about 1.2 keV at 1-MeV proton energy are given. Level strengths and total widths at selected energies were measured and the relevant quantities are compared in a table with those derived from work by Jones et al. (Phys. Rev., 145: 894(1966)). (S.F.L.)

11921 PHOTONEUTRON CROSS SECTIONS ON Al, S, Ta, AND Bi. Antropov, G. P.; Mitrofanov, I. E.; Russkikh, V. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 336-42(Feb. 1967). (In Russian).

A method is described for investigating the photoneutron cross sections of Al, S, Ta, and Bi nuclei using a 30-MeV betatron at 50 Hz. The (γ, n) reaction cross-sections obtained are compared with the existing literature data. The stepwise stabilization technique employed can be used in a wide class of photonuclear measurements assuring greater convenience and accuracy. The data obtained for the light nuclei are considered more accurate than those available in the literature. (JPRS)

11922 INELASTIC NEUTRON SCATTERING ON CARBON, ALUMINUM, IRON, AND BISMUTH NUCLEI. Broder, D. L.; Dovbenko, A. G.; Kolesov, V. E.; Lashuk, A. I.; Sadokhin, I. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 327-32(Feb. 1967). (In Russian).

The experimental results of a previous work dealing with γ-ray measurement are used to calculate γ-quantum cross sections in inelastic scattering of neutrons on C, Al, Fe, and Bi nuclei, taking into particular consideration the spin–orbital interaction in the nuclear potential. (JPRS)

11923 FLUCTUATION ANALYSIS OF THE EXCITATION FUNCTION FOR (p,p′) AND (p,α) REACTIONS ON ^{27}Al AT A PROTON ENERGY OF 6.4 MeV. Vasil'ev, S. S.; Mikhaleva, T. N.; Chuprunov, D. L. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 295-306(Feb. 1967). (In Russian).

The reactions $^{27}Al(p,p')$ and $^{27}Al(p,\alpha)^{24}Mg$, which are known to proceed directly in the case of (p,p′) and through a compound nucleus in the case of (p,α), were chosen to explain the results given by the full fluctuation analysis of the excitation function. The angular distributions were measured simultaneously for both channels on a 120-cm cyclotron. It is concluded that a full investigation of the excitation function (comprising the autocorrelation function, transverse cross-section distribution probability and cross-correlation function) is necessary for study of reaction mechanisms by the excitation function. The mechanism of the reaction channels studied can be represented as excitation in the nucleus of intermediate resonances with superimposed statistical fluctuations. (JPRS)

11924 EXPERIMENTAL INVESTIGATION OF 1- TO 2-MeV NEUTRON RESONANCE SCATTERING ON IRON NUCLEI. Guseinov, A. G.; Orlov, V. V.; Popov, V. I.; Suvorov, A. P.; Trykova, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 267-8 (Feb. 1967). (In Russian).

The fact of decrease in the number of neutrons at energies corresponding to resonance maxima in total cross sections is used as the basis of a method for studying the angular distribution of resonance scattering, in which a narrow beam of scattered neutrons in first filtered through the material of the diffuser. Analysis of differential scattering cross sections beyond filters of varying thickness gives information on the average differential cross section of scattering corresponding to various values of total cross section. Differential cross sections of elastic neutron scattering on Fe nuclei were determined for angles 30 to 150°. Initial data suggest that the method can be useful in the range of energies where the resolution of the existing neutron spectrometers is inadequate for study of differential resonance scattering cross sections. (JPRS)

11925 THE RESONANCE INTEGRAL OF ^{51}V. Geiger, K. W.; van der Zwan, L. (National Research Council, Ottawa). Nukleonik, 10: 277(Nov. 1967).

The ^{51}V neutron resonance integral was measured by comparing the Cd-ratio for V foil with the Cd-ratio for Au foil, for which the resonance integral is well known. The activations were carried out in a water bath, between two 500 mg Ra–Be neutron sources spaced 13 cm apart. An excess resonance integral of 0.36 ± 0.01 b was obtained for ^{51}V. (S.F.L.)

11926 LIFETIMES IN ^{40}Ca FROM DOPPLER-SHIFT ATTENUATION MEASUREMENTS USING A Ge(Li) DETECTOR. MacDonald, Jack R.; Start, D. F. H.; Anderson, R.; Robertson, A. G.; Grace, M. A. (Oxford Univ.). Nucl. Phys., A108: 6-26(1968).

Measurements were carried out on the mean lifetimes of five states in ^{40}Ca. The Doppler-shift attenuation method was used with a lithium-drifted germanium detector in a particle-gamma ray coincidence arrangement. The technique was checked by measurements of the known lifetimes of the 1.78-MeV state in ^{28}Si and the 1.45-MeV state in ^{58}Ni. Accurate excitation energies were obtained for ^{40}Ca states. The spin of the 5.21-MeV state was shown by a triple coincidence particle-gamma-gamma angular correlation measurement to be 0. The above data enable the parities of the states forming the triplet at 5.2 MeV to be fixed as positive. The results which imply enhancements of the electric quadrupole transitions are discussed in the light of the Gerace-Green model of a deformed ^{40}Ca nucleus. (auth)

11927 SPECTROSCOPIC FACTORS FROM THE REACTION ^{30}Si(d,p)^{31}Si. Wildenthal, B. H.; Glaudemans, P. W. M. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A108: 49-62(1968). (ORO-1316-48).

The reaction ^{30}Si(d,p)^{31}Si was studied at deuteron energies of 7.00 and 10.00 MeV, and angular distributions were measured for the transitions to the lowest seven states of ^{31}Si. The data are analyzed with the DWBA theory, and the spectroscopic properties of the states are extracted on this basis. Fluctuations in the experimental cross sections were investigated for deuteron energies between 6.5 and 7.5 MeV and were found to be less than 20% for the strongly excited states. The values of the spectroscopic factors S were found to depend significantly in some instances upon details of the DWBA calculations. (auth)

11928 THE ^{40}Ar(p,d)^{39}Ar AND ^{36}Ar(p,d)^{35}Ar REACTIONS AT 27.5 MeV. Johnson, R. R.; Griffiths, R. J. (Univ. of Colorado, Boulder). Contract AT(11-1)-535. Nucl. Phys., A108: 113-23(1968). (COO-535-568).

The levels of ^{39}Ar and ^{35}Ar were investigated by means of the (p,d) reaction at an incident energy of 27.5 MeV. Absolute differential cross sections of states up to 7.0-MeV excitation energies, angular momentum transfers, and spectroscopic factors using DWBA analysis were determined for many previously unknown states. (auth)

11929 A FLUCTUATION ANALYSIS OF THE REACTION ^{31}P(p,α)^{28}Si. Dallimore, P. J.; Allardyce, B. W. (Oxford Univ.). Nucl. Phys., A108: 150-76(1968).

The reaction ^{31}P(p,α)^{28}Si was investigated for alpha particles detected at 13 angles in the proton energy range 8.50 to 12.30 MeV, corresponding to excitations in the compound nucleus ^{32}S of between 17.36 and 21.16 MeV. The excitation functions were measured in 10-keV steps. The two α-particle groups α_0 and α_1 were recorded. All of the data, i.e., 26 excitation functions each of 380 points, are quantitatively in agreement with the Hauser-Feshbach statistical assumptions including statistical fluctuations. No evidence is found for direct interaction or for doorway states. The mean level widths of the compound nucleus for decay to the ground and first excited states of ^{28}Si were found to be 47 ± 7 keV and 42 ± 5 keV, respectively. The statistical dependences of these values on the range of data n and on the experimental values of the auto-correlation are discussed and found to be important considerations. (auth)

11930 THE GIANT DIPOLE RESONANCE EXCITED BY α CAPTURE. Meyer-Schutzmeister, L.; Vager, Z.; Segel, R. E.; Singh, P. P. (Argonne National Lab., Ill.). Nucl. Phys., A108: 180-208(1968).

The reactions ^{24}Mg(α,γ)^{28}Si from E_α = 5.3 MeV to 14.5 MeV, ^{26}Mg(α,γ)^{30}Si from 4.0 MeV to 13.5 MeV and ^{28}Si(α,γ)^{32}S from 7.0 MeV to 12.0 MeV were studied. These α energies lead into the region of the giant dipole resonance in the compound nucleus. The yield of γ rays leading to the ground state of the final nucleus, γ_0, was studied for each of the three targets; and for ^{24}Mg(α,γ) the radiation γ_1 goint to the first excited state was also studied with reasonable accuracy. The angular distributions of γ_0, which were measured in 100-keV steps over a wide range of energies for the ^{24}Mg and ^{26}Mg targets and at two energies for the ^{28}Si target, showed a dominant electric-dipole transition. This indicates that the (α,γ_0) reactions lead predominantly through the giant dipole resonance in ^{28}Si and ^{30}Si and most likely also in ^{32}S. The gamma-ray yield, which was measured in steps of 30 or 100 keV over the energy ranges studied, exhibited strong fluctuations in each case. For α capture both in ^{24}Mg and in ^{26}Mg, statistical analysis of the fluctuations showed that the reactions proceed nearly 100% throug compound-nucleus formation and that the average width of the compound-nucleus resonances is about 60 keV. The integrated cross sections of these three alpha-capture reactions led to the conclusion that formation of the giant resonance by alpha capture is strongly inhibited even in cases in which the alpha capture is isospin allowed. This is expected since the giant dipole resonance is supposed to consist predominantly of particle-hole states. Earlier experiments of proton capture by ^{27}Al had shown that only a small part of the giant dipole resonance in ^{28}Si leaks into the more complicated nucleon configurations of the compound nucleus. The observation that this part of the giant dipole resonance in ^{28}Si decays with comparable strength by α-particle and proton emission indicates that it has a strong admixture of isospin T = 0. (auth)

11931 LIFETIME MEASUREMENTS IN ^{38}Ar. Lieb, K. P.; Roepke, H.; Grawe, H.; Brundiers, H. J.; Klepper, O. (Univ., Freiburg i. B.). Nucl. Phys., A108: 233-40(1968).

From Doppler shift attenuation and delayed coincidence measurements in the reaction ^{35}Cl(α,pγ), lifetimes were determined for the ^{38}Ar states at 3.81 MeV (τ = 0.15 ± 0.05 ps), 4.48 MeV (τ > 1.0 ps), 4.59 MeV ($\tau \leq$ 350 ps) and 4.89 MeV (τ = 0.24 ± 0.08 ps). Analogies to levels in ^{40}Ca are discussed. (auth)

11932 SOME INVESTIGATIONS ON THE DECAY OF ^{60}Co. Hansen, H. H.; Spernol, A. (EURATOM, Geel, Belg.). Z. Phys., 209: 111-18(1968).

The ^{60}Co decay was reinvestigated using an electromagnetic β spectrometer and a Ge(Li) γ spectrometer. A new weak β^- transition of character ΔJ = 3 with no parity change between the 5^+ ground state of ^{60}Co and the second excited 2^+ level at E = 2.155 MeV in ^{60}Ni could be established. The endpoint energies and intensities of the three β^- transitions are given. The intensity ratio of the stopover and crossover γ transitions de-exciting the 2.155-MeV level was determined to be ≧120. Some conclusions for the theory are discussed. (auth)

11933 INFLUENCE OF THE EXPERIMENTAL ERRORS ON THE DETERMINATION OF THE OPTICAL MODEL PARAMETERS FOR ALPHA PARTICLES. Budzanowski, A.; Dymarz, R.; Grotowski, K.; Strzalkowski, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 32: 861-9 (Nov. 1967).

The angular distribution of 24.7-MeV alpha particles scattered elastically on Co nuclei was analyzed by means of the optical model of the interaction. The influence of different kinds of experimental errors on this analysis was studied. These errors are as follows: individual errors of successive experimental points in the angular distributions, the error in the absolute value of the cross-section, the error in the estimation of the zero point of the angular scale, and error in the measurement of the energy of incident particles. (auth)

11934 BETA DECAY OF ^{87}Y ISOMER. Miyano, Kazumasa (Tokyo Univ.). J. Phys. Soc. Jap., 23: 1191-6(Dec. 1967).

The decay of the isomeric state of ^{87}Y was reinvestigated using scintillation and Ge(Li) spectrometers. This work leads to the conclusion that its half-life is 12.5 hours instead of 14 hours obtained in the previous study. A weak branching of a beta ray with a maximum energy of 1.54 MeV was found. It was assigned to be a direct transition from the isomeric state ($1g_{9/2}$) of ^{87}Y to the ground state ($1g_{9/2}$) of ^{87}Sr. This allowed transition was found to be comparatively hindered, and the log ft value obtained was 7.6. Its branching ratio was found to be $6.2 \pm 1.2 \times 10^{-6}$. An end-point energy of a beta ray from the ground state of ^{87}Y was found to be 0.78 MeV; its log ft value was 6.2. The 1.54-MeV beta branching was discussed qualitatively in terms of the pairing theory. (auth)

11935 INTERNAL CONVERSION AND MULTIPOLE RADIATION BETWEEN EXCITED STATES OF SOME MEDIUM-WEIGHT NUCLEI. Menti, Walter (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 981-1011(Dec. 30, 1967). (In German).

The measurement of the internal conversion coefficients and the gamma-ray angular distributions of ^{47}V; 88.1 keV; ^{49}V; 90.4 and 152.3 keV; ^{56}Co: 157.2 keV; ^{63}Zn: 193.0 keV; ^{61}Zn: 115.5 and 154.3 keV; ^{66}Ga: 172.5 and 196.7 keV offers a possibility of determining the nuclear spin and parity of the excited states and the multipole mixing ratio of the gamma transitions. The level schemes up to 300 keV of the nuclei are discussed and are compared with the predictions of the nuclear models. (auth)

11936 NEUTRON TOTAL CROSS SECTION MEASUREMENTS USING A "WHITE" NEUTRON SOURCE. Galloway III, Louie Altheimer. Cleveland, Case Inst. of Tech., 1966. 131p. Thesis.

A method for measuring neutron total cross sections using a neutron intensity spectrum continuous in energy (a "white" spectrum) and a pulsed beam time-of-flight technique was used to measure neutron total cross sections in the 2 to 10 MeV region. Total cross sections for the elements Mg, Al, Ca, V, Fe, Pd, Ag and Pb were measured to 1% average uncertainty in steps of 0.08 ns/m. Energy resolution varied from about 1.5% at 2 MeV to 3% at 10 MeV. Results of these measurements are compared with measurements on the same samples with neutrons of known energy and with measurements of other workers. (Disser. Abstr.)

11937 INVESTIGATION OF ^{40}Ca BY THE ^{39}K(p,γ_0)^{40}Ca AND ^{39}K(p,α_0)^{36}A REACTIONS. Bartko, John. University Park, Pa., Pennsylvania State Univ., 1966. 97p.

Thesis.

A previously uninvestigated region of excitation in ^{40}Ca was investigated by means of the ^{39}K(p,γ_0)^{40}Ca and ^{39}K(p,α_0)^{36}A reactions. The target material was natural K. A NaI(Tl) anticoincidence spectrometer was used for the gamma rays, and a Si surface barrier detector was used for the alpha particles. Excitation curves were obtained for both reactions, from E_p = 2.8 MeV to 6.1 MeV for the (p,γ_0) reaction and from E_p = 2.9 MeV to 6.1 MeV for the (p,α_0) reaction. The relative resonance strengths for most of the (p,γ_0) resonances were determined with respect to the $\omega\gamma$ for a strong resonance at E_p = 2.045 MeV, for which the absolute $\omega\gamma$ is known. Angular distribution measurements were made of six (p,α_0) resonances at E_p = 3.45, 3.64, 3.86, 4.51, 4.99, and 5.08 MeV and three (p,γ_0) resonances at E_p = 4.45, 4.90 and 4.99 MeV. (Disser. Abstr)

11938 ELASTIC SCATTERING OF ALPHA PARTICLES BY ^{24}Mg. Crawford, Gary Edward. Tallahassee, Fla., Florida State Univ., 1967. 86p.

Thesis.

Detailed angular distributions were measured for the elastic scattering of alpha particles by ^{24}Mg in approximately 100 keV intervals throughout the energy range 7.8 to 18.1 MeV. Measured excitation curves reveal strong fluctuations of cross section with energy. A description of the ^{24}Mg(α,α)^{24}Mg reaction was sought in terms of the nuclear optical model. Qualitative fits to both good resolution and energy averaged angular distributions were found using a four parameter optical potential. Values of real potential in the neighborhoods of 55, 80, 115, 150, and 185 MeV gave similar fits with radius and diffuseness parameters of 4.87 F and 0.65 F for averaged data in the energy range 14.0 to 17.4 MeV. Optical model calculations including an approximation for the compound elastic scattering gave improved fits but indicate that compound elastic effects are small. Total compound elastic cross sections are found to be the order of 15 mb. (Disser. Abstr.)

11939 ISOBARIC SPIN CONSERVATION IN THE ^{40}Ca(d,α)^{38}K REACTION. Hemsky, Joseph William. Lafayette, Ind., Purdue Univ., 1967. 93p.

Thesis.

The angular distributions of the five most energetic alpha groups emitted in the reaction ^{40}Ca(d,α)^{38}K at a deuteron energy of 9.20 MeV were measured with a broad-range spectrograph from 15° to 155°. The differential cross section for the transition to the J^π, $T = 0^+$,1 state at 0.129 MeV is nearly symmetrical about 90° and is inhibited by the $\Delta T = 0$ isobaric-spin selection rule by about a factor of 3 after adjustment for the inhibition due to parity and angular momentum. This corresponds to an isobaric spin mixing in the compound nucleus of about 20 to 25% which is a considerable decrease from the nearly complete mixing previously reported by Jänecke for a deuteron energy of 7.7 MeV. This could be the predicted decrease at high excitation energies in the compound nucleus where $\langle H_c \rangle \ll \langle \Gamma \rangle$. A fit of the angular distribution with a quadratic form of associated Legendre polynomials $P_l^1(\cos\theta)$ revealed very large cross terms which may indicate a deviation from a statistical compound-nucleus reaction larger than expected from the limited energy spread (about two coherence widths). The angular distribution of the transition to the 2^+,1 fourth excited state (at 2.406 MeV) has forward peaking and may have a direct-interaction component in approximate agreement with the impurities in the initial and final states. A comparison of the angular distributions for the transitions to the 3^+,0 ground state and the 1^+,0 states at 0.456 and 1.701 MeV at 9.20 MeV with previous work at 7.7, 11.4, and 14.8 MeV does not show any obvious general trends. (Disser. Abstr.)

11940 MOESSBAUER EFFECT FOLLOWING THE REACTION ^{56}Fe(d,p)^{57}Fe* AND ITS APPLICATION TO NUCLEAR POLARIZATION STUDIES. Goldberg, David Arthur. Baltimore, Johns Hopkins Univ., 1967. 119p.

Thesis.

A Mössbauer effect from the 14.4 keV level in ^{57}Fe was observed following the reaction ^{56}Fe(d,p)^{57}*Fe at E_d = 2.8 MeV. The resolvable hyperfine pattern resulting from the use of a metallic iron target was observed using an enriched ^{57}Fe metallic absorber, and the resulting transmission spectrum was compared with one obtained using a ^{57}Co-in-Fe source under the same experimental conditions. Comparison of the widths and positions of the central absorption dips indicates no discernible difference in either the magnetic or chemical environment between the Co source and recoil target nuclei. Comparison of areas under the central absorption dip indicates no significant reduction in recoilless fraction in the bombardment experiment. The results appear to indicate that the recoiling target nuclei produce little disruption of the existing lattice, and that all but a negligible fraction of the nuclei come to rest at normal lattice sites; this is in agreement with calculations based on a dynamical theory of radiation damage as proposed by Vineyard. The Mössbauer effect is shown to be a useful technique for studying nuclear polarization following stripping reactions. Several experiments are proposed for studying the nuclear polarization in the particular reaction ^{56}Fe(d,p)^{57}*Fe. (Disser. Abstr.)

11941 PROTONS FROM 14.3 AND 16.6 MeV NEUTRON INDUCED REACTIONS IN ^{63}Cu. Eddy, Jerry Kenneth. Morgantown, W. Va., West Virginia Univ., 1967. 133p.

Thesis.

The energy spectra and angular distributions of protons produced from bombarding ^{63}Cu with 14.3 and 16.6 MeV neutrons were studied. These studies were made with a proton telescope using two CsI(Tl) transmission counters and a CsI(Tl) total absorption crystal. Proton energy spectra were taken at 0, 20, 45, 70, 95, and 120 degrees with the neutron beam for both neutron energies. The energy spectra were compared with the theoretical cross-sections calculated from the statistical model of the nucleus and the volume direct interaction theory of nuclear reactions. For the 14.3 MeV incident neutrons, the proton spectra showed peaks at 9, 10, and 13.5 MeV. Nuclear temperatures were determined at each angular position giving 1.2 MeV at 0°, 1.63 MeV at 20°, 1.63 MeV at 45°, 1.53 MeV at 70°, 1.63 MeV at 95°, and 1.63 MeV at 120°. The average nuclear temperature is 1.54 MeV. From the angular distributions, the percentage of direct interactions present above 5 MeV protons was estimated to be 25%. For the 16.6 MeV incident neutrons, the proton spectra showed a peak at 16 MeV. The nuclear temperatures determined at each angle were 1.50 MeV at 0°, 1.50 MeV at 20°, 1.30 MeV at 45°, 1.46 MeV at 70°, 1.22 MeV at 95°, and 1.46 MeV at 120°. The average nuclear temperature is 1.41 MeV. The percentage of direct interactions present above 5 MeV protons was determined from the angular distributions as 77.4%. The angular distributions are compared with the theoretical distributions calculated from the volume direct interaction theory. For 14.3 MeV neutrons, the proton energy spectra contain a considerable statistical model contribution, thus the angular distribution fit to the theoretical curve was not very good. For 16.6 MeV neutrons, the proton energy spectra are predominately direct, thus the angular distribution fit to the theoretical curve was very good. (Disser. Abstr.)

11942 NUCLEAR STRUCTURE STUDIES OF ^{88}Sr, ^{89}Y, ^{92}Zr, AND ^{94}Zr USING 19 MeV PROTON INDUCED REACTIONS AND THE ^{88}Sr(^{3}He,d) REACTION. Stautberg, Margaret Mary. Boulder, Colo., Univ. of Colorado, 1966. 152p.

Thesis.

Elastic and inelastic angular distributions were obtained for approximately 19 MeV protons scattered from ^{92}Zr, ^{94}Zr, ^{88}Sr, and ^{89}Y. Several deuteron and triton groups from the (p,d) and (p,t) reactions on ^{92}Zr and ^{94}Zr were observed and angular distributions obtained. Deuteron angular distributions were also obtained from the ^{88}Sr(^{3}He,d)^{89}Y reaction with an incident ^{3}He energy of 37.7 MeV. The inelastic angular distributions were compared with distorted wave theory using a collective model form factor to obtain level structure information. The energies of the states in ^{92}Zr, ^{94}Zr, ^{88}Sr, and ^{89}Y were determined. The deuteron angular distributions from the ^{88}Sr(^{3}He,d)^{89}Y reaction were compared with the distorted wave theory of stripping reactions. The states in ^{89}Y and the shell model orbit of the stripped protons were determined. The angular distributions for several states in ^{92}Zr, ^{94}Zr, and ^{89}Y were compared with distorted wave calculations using shell model wave functions for the initial and final nuclear states. An effective inter-nucleon potential of the Yukawa form with a range of 1 F and depth approximately 200 MeV was used. This model was successful in predicting the magnitude and shape of angular distributions for states having the $(d_{\frac{5}{2}})^2$ and $(d_{\frac{5}{2}}, d_{\frac{3}{2}})$ configurations in ^{92}Zr, and the $(d_{\frac{5}{2}})^{-2}$ configuration in ^{94}Zr. The 0.91-MeV state of ^{89}Y was analyzed as a $2p_{\frac{1}{2}} \rightarrow 1g_{\frac{9}{2}}$ proton transition, the 1.49-MeV state, as a $2p_{\frac{3}{2}} \rightarrow 2p_{\frac{1}{2}}$ proton transition, and the 1.74-MeV state, as a $1f_{\frac{5}{2}} \rightarrow 2p_{\frac{1}{2}}$ proton transition. The analysis of the deuteron angular distributions from the (p,d) reaction on ^{92}Zr and ^{94}Zr removed the ambiguity in the deuteron optical model parameters. (Disser. Abstr.)

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Refer also to abstracts 10544, 10553, 10565, 10580, 11551, 11921, 11922, and 11942.

11943 (AE-300) LEVELS AND TRANSITION RATES IN ^{199}Au. Malmskog, S. G.; Backlin, A.; Fogelberg, B. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1967. 48p. Dep.

The decay of ^{199}Pt to ^{199}Au ($T_{\frac{1}{2}}$ = 30.8) was investigated using a Ge(Li) detector and a double-focusing beta spectrometer. Thirty-four transitions were found, and multipolarities were assigned for 11 of these including a 55.15-keV M2 + (0.9 ± 0.5)% E3 isomeric transition. Using these data together with the results of γ-γ and β-γ coincidence measurements, a decay scheme containing 9 excited levels and 25 transitions was constructed; and spin and parity assignments were made. Using the delayed-coincidence technique, half-lives were determined for 3 levels; and upper limits were obtained for 5 additional levels. The following levels were found: 77.21 ± 0.03 keV ($\frac{1}{2}^+$, 1.1 ± 0.1 ns); 316.98 ± 0.10 ($\frac{5}{2}^+$, <55 ps); 323.57 ± 0.09 keV (($\frac{1}{2}$), $\frac{3}{2}^+$, 35 ± 20 ps); 493.59 ± 0.10 keV ($\frac{1}{2}^+$, <35 ps); 542.82 ± 0.07 keV ($\frac{5}{2}^+$, <30 ps); 548.65 ± 0.09 keV ($11\frac{1}{2}^-$); 734.44 ± 0.11 keV ($\frac{7}{2}^-$, 0.36 ± 0.04 ns); 791.47 ± 0.15 keV ($\frac{3}{2}^+$, $\frac{1}{2}^+$, <50 ps); and 967.98 ± 0.20 keV ($\frac{3}{2}^{(+)}$, $\frac{5}{2}^{(+)}$, <100 ps). The decay properties of the lowest excited positive-parity levels are discussed in terms of de Shalit's core excitation model. (auth)

11944 (AECL-2780) PHYSICS DIVISION PROGRESS REPORT JULY 1, 1967 TO SEPTEMBER 30, 1967. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 79p. (PR-P-75). Dep. CFSTI. CAN $2.00.

The tandem accelerator has been working well since July, when there were some mechanical difficulties, and the research program has been almost uninterrupted. Satisfactory beams of oxygen ions were obtained from the duoplasmatron ion source, and a lithium exchange canal was installed to provide helium ion beams. The 33, 56, and 70° beam lines in Target Room 1 are now complete. The focal surface of the broad-range magnetic spectrograph was accurately located, and a resolution of better than 0.1% in energy was obtained over the whole surface. The spark chamber was found to be insufficiently rigid and is being modified; the plastic scintillator used to trigger the chamber is being replaced by a very fast proportional counter which provides mechanical support. The differentially pumped gas target was installed in the new gamma cave, and experiments were carried out on the capture of ^{16}O ions in helium. The ^{4}He(^{16}O,γ)^{20}Ne reaction is more favorable than the ^{16}O(α,γ)^{20}Ne reaction because of lower background, and the gamma rays from the decay of the 6$^+$ resonance at 8.79 Mev in ^{20}Ne were seen very clearly. Gamma rays from the 8$^+$ level at 11.99 Mev (the next number of the ground-state rotational band) have not yet been observed; a reduction in background by a factor of about two is required. Lotus, the new gamma-detector array, was set up with six NaI(Tl) detectors and one 40-cm^3 Ge(Li) detector to study levels in ^{28}Mg excited by inelastic proton scattering. At 6.8-Mev proton energy gamma rays from the lowest eleven states were observed in coincidence; the highest eight of these have not previously been investigated by gamma-ray correlation techniques. These include seven levels that require a Ge(Li) detector to resolve the gamma rays. At the NRU reactor the fast chopper was installed; and initial trial measurements, with NaI detectors, were made of known spectra from boron and gold. The gamma ray monochromator facility is being used to study photofission in ^{235}U and ^{238}U. Two ING-related studies were completed. A theoretical investigation of muon and pion production showed that there is no optimum proton energy—up to 1 GeV the higher the proton energy the greater the stopped meson production. Measurements of the change in slow neutron flux when a Pu–Be neutron source in heavy water is surrounded by beryllium showed that a beryllium "multiplier" would have no useful function in the ING target assembly. The triple-axis spectrometer at the C5 facility of the NRU reactor was used to study magnons and phonons propagating in (antiferromagnetic) single crystal $KCoF_3$ at liquid helium temperatures. Two modes were observed of frequencies (10^{12} cycles sec^{-1}) 1.19 ± 0.03 and 1.72 ± 0.04 at q = 0 which increased in the [ζζ0] direction (without crossing) to 3.13 ± 0.06 and 6.26 ± 0.10 at the zone boundary. Measurements above 114°K lead to the conclusion that the upper mode is magnetic at the zone boundary but the lower is magnetic at the origin. The fact that the modes do not cross in the antiferromagnetic state is evidence for magnon-phonon interaction. A spin-wave model, with parameters obtained from the experimental results for the two lowest magnon branches, is being used to predict frequencies and intensities of the upper magnon branches, and hence to plan future experiments. Phonons in KD_2PO_4 were studied in order to investigate their relation to the ferroelectric phase transition at 220°K, where the deuterium atoms become ordered. The lowest frequency phonons were found to be insensitive to temperature; their frequencies would be expected to decrease with temperature if the normal modes were unstable against a ferroelectric transition (at q = 0) or an antiferroelectric transition (at the zone boundary). A search in the a-c plane at zero energy transfer revealed intense broad distributions centered on reciprocal lattice points such as (3, 0, 1) and (3, 0, 3). This scattering increased as the transition temperature was approached from the paraelectric phase; it is considered to be due to a collective mode associated with the incipient ordering of the deuterium atoms. The system Sn(Ge)Te exhibits ferroelectric behaviour for a wide range of germanium concentrations. The transition temperature decreases as the germanium concentration is decreased, being in the region of room temperature for 30% concentration. Room temperature measurements with the triple axis spectrometer at hole C4, NRU, of the inelastic neutron scattering from TO modes of zero wave-vector for Sn(Ge)Te crystals containing 0% and 20% germanium yielded frequencies of 1.35 ± 0.03 and 1.20 ± 0.15 (10^{12} cps) respectively, but, for the 30% sample, the TO mode could not be observed. It is suspected that this last result is caused by the crystal having already made the transition to the ferroelectric state. These observations are consistent with the expectation that the TO mode is reduced in frequency as Ge is added to the system. This results in the observed behaviour of the temperature of the ferroelectric transition (where $\omega_{TO} \to 0$). A cylindrical double-open-end coaxial diode was operated as a spectrometer before and after removal of the central undrifted p-type core. The original diode was made from a crystal of total volume 59 cm^3 and, after drift, had a sensitive volume of 42 cm^3. The core (~9 cm^3) was drilled out using a hollow diamond-impregnated drill. The peak/total ratios for ^{137}Cs and ^{60}Co were 50% higher after coring, because of an increased number of full-energy pulses and a reduction in the number of pulses from low-energy scattered γ rays. A set of routines for the G-20 was written which will allow programs written in APEX to select as an output device the DEC 338 graphic display system owned by EC & ID branch. EC & ID branch are building the interface which will allow communication between the G-20-3100 system and the DEC 338 display. Programs written for use in the G-20 computer include the following: a program for converting PDP-8 punched tape to a printed listing, a program for the accounting of computer use, a program to determine mechanical properties of test specimens from load-deformation data, a subroutine for summing complex Fourier series (Cooley–Tookey algorithm), and an APEX program for calculating multiple Coulomb excitation probabilities and gamma-ray angular distribution tensors (based on a Cal. Tech. FORTRAN program). A program is being written for controlling the circulation of books from the Chalk River library. (auth)

11945 (ANL-7384) PHYSICS DIVISION SUMMARY REPORT, JULY–SEPTEMBER 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 61p. Dep. CFSTI.

Research on the energy dependence of high-energy K-conversion coefficients, perturbation of the statistical properties of nuclear states and transitions by interactions that are odd under time reversal, and autoionization in H_2 is reported. Summaries of papers presented at meetings and of papers accepted for publication are included. (D.C.W.)

11946 (COO-1716-4) THERMODYNAMIC STUDIES ON HEAVY ELEMENTS AND STUDIES IN NUCLEAR CHEMISTRY. Annual Report, February 1967–January 1968. Cobble, J. W. (ed.) (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Jan. 1, 1968. Contract AT(11-1)-1716. 19p. Dep. CFSTI.

Progress is reported in nuclear fission research (including ternary fission of ^{238}U induced by intermediate energy ^{4}He ions; ternary fission of ^{238}U induced by intermediate energy ^{3}He ions; ternary fission of ^{232}Th induced by intermediate energy ^{4}He ions; ternary fission studies on ^{209}Bi induced by intermediate energy ^{4}He ions; fission studies on iridium; excitation functions for the helium-ion induced fission of rhenium, lutetium, and thulium; and fission of rhenium by intermediate energy helium ions), general nuclear research (radiochemical searches for polymeric neutrons), and physical-inorganic research (thermodynamic function of Np(V) and Np(VI); heat of solutions of plutonium metal and the entropy of Pu(III); and the entropies of the trivalent lanthanide and actinide ions). (D.H.M.)

11947 (MIT-952-4, pp 220-66) NUCLEAR PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Level structures in the ^{227}Ac decay series above ^{219}Rn were studied in detail by alpha–gamma coincidence and alpha–gamma

angular correlation methods. Work is continuing on the accurate measurements of total internal conversion coefficients in some heavy even-even nuclides. (auth)

11948 (NP-17216) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1966. McMurray, W. R. (comp.) (Southern Universities Nuclear Inst., Faure (South Africa)). 56p. Dep.

Neutron capture, fission, and scattering were investigated as were charged-particle reactions and scattering. The resonance absorption of γ rays from (p,γ) reactions was studied. Information on the level schemes of some nuclei was obtained. Techniques for fast neutron activation analysis of hydrogenous materials, analysis using neutron time-of-flight spectrometry with charged-particle-induced reactions, and charged-particle activation analysis were investigated. (D.C.W.)

11949 (ORO-2972-47) ANNUAL REPORT, JANUARY-DECEMBER 1967. (Texas Univ., Austin. Center for Nuclear Studies). Contract AT(40-1)-2972. 107p. Dep. CFSTI.

Experimental and theoretical investigations of deuteron-induced reactions and of proton-induced reactions and scattering were performed with emphasis on isobaric analog resonances and on charge-exchange coupling in deuteron stripping. Neutron total elastic and nonelastic cross sections were measured for ^{10}B and ^{14}N. A technique for studying the electromagnetic structures of the pion was analyzed. Developments in instrumentation are also summarized. (D.C.W.)

11950 (ORO-3624-1) PROGRESS REPORT [ON NUCLEAR PHYSICS], NOVEMBER 1, 1967. Seagondollar, L. W. (North Carolina State Univ., Raleigh). Contract AT(40-1)-3624. 61p. Dep. CFSTI.

Theoretical formalism was developed for interpreting a broader class of reactions in terms of the knock-out mechanism; and the systematics of nuclear binding energies of $A \leq 60$ nuclei, including excited states, were investigated. The reactions ^{9}Be(d,n)^{10}B, ^{9}Be(d,p)^{10}Be, ^{113}Cd(n,γ)^{114}Cd, ^{40}Ca(He-3,α)^{39}Ca, ^{13}C(He-3,d)^{14}N, ^{24}Mg(He-3,α)^{23}Mg, and ^{32}S(p,γ)^{33}Cl were studied experimentally, as was the beta decay of ^{194}Ir. Information on the energy levels of ^{39}Ca, ^{23}Mg, ^{237}Np, ^{239}Np, ^{14}N, ^{194}Pt, and ^{233}Pa was obtained; lifetime measurements were made for some of the levels using the γ Doppler-shift attenuation method. Techniques were developed for fabricating Ge(Li) detectors, and a three-crystal pair spectrometer using scintillation and semiconductor detectors was designed. (D.C.W.)

11951 INVESTIGATION OF CONVERSION ELECTRON COINCIDENCE IN ^{165}Tm DECAY. Dzhelepov, B. S.; Tishkin, P. A.; Shishelov, I. A. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 205-16(Feb. 1967). (In Russian).

The ee-coincidence of conversion electrons was investigated in a tandem toroidal β-spectroscope at $\Delta H_\rho/H_\rho \approx 2\%$. The measurements were done at conversion lines K242.7, K218.6, and L77.2 of ^{165}Tm, for which the coincidence values are listed. Two new levels with excitation energies of 477.5 and 745.5 keV were added to the decay diagram of ^{165}Tm. The positions of various transitions are assigned on the basis of the experimental results obtained. (JPRS)

11952 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY ^{148}Sm, ^{154}Sm, AND ^{174}Yb. Kurepin, A. B., Madsen, B.; Elbek, B. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 195-204(Feb. 1967). (In Russian).

A stabilized spectrometer and a telescopic system consisting of two dE/dx and one E surface barrier silicon counters were used to obtain good energy resolution of scattered protons. The results of measurements of elastic and inelastic scattering of protons by ^{148}Sm, ^{154}Sm, and ^{174}Yb and a comparison of the scattering patterns of protons and deuterons on heavy nuclei has shown that the former conveys more information and can be successfully used in spectroscopy. The shape of the angular distribution curve at 2^+ appears to give information on whether this level is vibrational or rotational. Given the development of a suitable theory, inelastic proton scattering may possibly also be used to determine level spins and parities. (JPRS)

11953 ON THE POSSIBILITY OF CONDUCTING THE (n,α) REACTION WITH THERMAL NEUTRONS. Dadakina, A. F. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 310-14 (Feb. 1967). (In Russian).

On the basis of a theoretical consideration of complex particle formation, it is concluded that no weighty evidence exists to support the hypothesis that a large proportion of fragments is formed in processes described by the statistical model. It is extremely difficult to obtain information on the true nature of the phenomenon using only the experimental data from the area of applicability of statistical approximation. (JPRS)

11954 INVESTIGATION OF THE IRIDIUM FRACTION RADIATION. Sychikov, G. I.; Burminstrov, V. P.; Vodolazhskaya, I. S.; Kovrigin, O. D.; Novgorodov, A. F. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 269-76(Feb. 1967). (In Russian).

The γ-spectrum and internal conversion electron spectrum of the Ir fraction from a proton (660 MeV) bombarded gold target were determined on a semiconductor γ-spectrometer with a Ge(Li) detector and a magnetic β-spectrometer, respectively. The values obtained for ^{189}Ir, ^{190}Ir, and ^{192}Ir are in agreement with literature data. The γ-line at 345 ± 5 keV is attributed to ^{191}Pt. An electron spectrum observed is attributed to ^{192}Pt. Conversion lines indicating the presence of low activity ^{188}Pt isotopes were observed. No traces of Ta, W, or Au were detected. (JPRS)

11955 INVESTIGATION OF ^{150}Sm LEVELS EXCITED IN THE (n,γ) REACTION BY THE e γ-COINCIDENCE METHOD. Govor, L. I.; Ivanov, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 277-83 (Feb. 1967). (In Russian).

Cascade transitions in the ^{150}Sm nucleus following the ^{149}Sm(nγ) ^{150}Sm reaction were studied to test the existence of the 1278-keV state decaying with emission of α-quanta with energy of 505 keV postulated in the literature. The conversion electrons and γ-rays produced in neutron capture were measured with a magnetic and a luminescence spectrometer. Evidence favoring the existence of the 1278-keV level was found. The apparatus used permits the study of e γ-coincidence in the (n,γ) reaction. A good effect-background ratio is obtained for isotopes with capture cross sections >500 barns. (JPRS)

11956 β RADIATION OF ^{38}K, ^{38*}K, AND ^{52}V, AND γ RADIATION OF Au IRRADIATED WITH α-PARTICLES. Vasil'ev, V. V.; Dzhordzh, E. T.; Shantvalov, L. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 284-6(Feb. 1967). (In Russian).

The β-spectrum with the upper limit $E_{\beta-}$ = 2.42 MeV and $T_{1/2}$ = 3.6 min measured on α-particle bombardment of ^{50}Ti-enriched Ti is attributed to ^{52}V · $E_{\beta+}$ values close to literature data were obtained for ^{38}K. The value of $E_{\beta+}$ = 5.1 MeV is attributed to the decay of ^{38*}K. Conversion electrons with E_e = 51 keV were detected upon irradiation of Au with α particles at 25 MeV, probably due to the reaction ^{197}Au(α,pn)^{199}Hg. (JPRS)

11957 QUADRUPOLE MOMENTS OF DEFORMED NUCLEI. Berlovich, E. E.; Novikov, Yu. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 287-94(Feb. 1967). (In Russian).

Direct measurements give inaccurate quadrupole moment values. Literature data are analyzed from the viewpoint that the γ-transition probability gives much more information on the electrical characteristics of the ground state of nuclei. The quadrupole moments of even-even nuclei from the time and Coulomb data are listed for $148 \leq A \leq 192$ to show their essential agreement. In the case of Gd, Yb, and Os with deviant values, a calculation was made using experimental values of the conversion factor to demonstrate that the differences between the time and Coulomb data cease to exist. The quadrupole moments of odd deformed nuclei $153 \leq A \leq 191$ are also analyzed. (JPRS)

11958 MEASUREMENT OF THE SCATTERING CROSS SECTIONS OF THERMAL AND EPITHERMAL NEUTRONS ON ERBIUM ISOTOPES. Vertebnyi, V. P.; Kolotyi, V. V.; Pisanko, Zh. I. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 353-4(Feb. 1967). (In Russian).

Scattering cross sections for neutrons at 0.007 to 1 eV on all the Er isotopes were measured using a mechanical interrupter. Scattered neutrons were detected in 4π geometry. The capture cross sections thus calculated were found to be in agreement with literature data. The corrected results can be used to determine the scattering amplitudes for the individual isotopes. (JPRS)

11959 THE DECAY OF ^{90}Nb. Pettersson, H.; Antman, S.; Grunditz, Y. (Univ. of Uppsala). Nucl. Phys., A108: 124-44 (1968).

The decay of 14.60 ± 0.05 h ^{90}Nb was investigated with a double focusing iron-yoke spectrometer and with a Ge(Li) detector. The endpoint energy of the intense (53 ± 6%) positon branch was determined to be 1500 ± 4 keV, leading to a Q-value of 6111 ± 5 keV. Some 17 transitions were found in the internal conversion spectrum, and among these are six not previously reported at 518, 828, 1575, 1717, 1914, and 2223 keV. The K-conversion coefficients were determined by combining the internal conversion intensities with the gamma-ray intensities. For many transitions, probable multipolarity assignments were obtained from these coefficients and also from $K/\Sigma L$ and $L_I/(L_{II} + L_{III})$ ratios. The M-conversion intensities of the 133 and 141 keV transitions were found to be in agreement with the recent tabulations of Hager and Seltzer. All transitions observed were fitted into a tentative decay scheme, which in its lower part is in agreement with shell-model calculations. (auth)

11960 THE ENERGY DEPENDENCE OF THE ANGULAR DISTRIBUTION OF FISSION GAMMA RAYS FROM ^{235}U IRRADIATED BY THERMAL NEUTRONS. Kluge, Gyula; Lajtai, Albert. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem., 15: 333-9 (1967). (In Hungarian).

The angular distribution of gamma rays from the thermal neutron-induced fission of ^{235}U was measured with respect to photon threshold energies of 40, 120, and 600 keV. The intensity of the gamma radiation was found to be higher in the direction of fission-fragment motion than in that normal to it. The anisotropy varies between 5 to 10% depending on the energy of the gamma rays involved, being larger for the lower and smaller for the higher threshold energies. (auth)

11961 THE DECAY OF ^{239}U. Mackenzie, D. R. (Brookhaven National Lab., Upton, N. Y.); Connor, R. D. Nucl. Phys., A108: 81-93(1968). (BNL-11691).

A study of the decay of ^{239}U with a lithium-drifted germanium detector revealed a complex γ spectrum, and the level scheme of ^{239}Np was extended up to 994 keV. A total of 37 γ transitions was observed, and their intensities were determined. Rotational levels represented by the Nilsson assignments $5/2^+[642]$ and $5/2^-[523]$ are in evidence as is also the β-vibrational level based on $5/2^-[523]$ at an energy of 662 keV. Above this energy a new system of levels is reported for the first time. Their nature is probably in part vibrational. New systems of levels are proposed to accommodate γ-ray transitions of intermediate energy. (auth)

11962 LOW-ENERGY GAMMA-RAY INTENSITIES IN THE DECAY OF $^{152\ 154\ 155\ 156}Eu$. Alexander, Peter (California Inst. of Tech., Pasadena. Isotopes, Inc., Westwood, N. J.). Nucl. Phys., A108: 145-9(1968).

A reexamination of the low-energy gamma rays produced in the decay of $^{152,154,155,156}Eu$ was made using the Caltech bent-crystal gamma-ray spectrometer. Sources of high specific activity were obtained by neutron capture in enriched ^{151}Eu and ^{153}Eu. The relative intensities of 11 gamma transitions were in most cases determined with an accuracy of better than 5%. The branching ratios in ^{155}Gd are discussed in terms of the collective model. (auth)

11963 HIGH-RESOLUTION STUDIES IN THE DECAY OF ^{133}Ba WITH SEMICONDUCTOR COUNTERS. Bosch, H. E. (Univ. of California, Berkeley); Haverfield, A. J.; Szichman, E.; Abecasis, S. M. Nucl. Phys., A108: 209-20(1968).

A reinvestigation of some properties of the decay of ^{133}Ba was carried out with high-resolution equipment based on Li-drifted silicon and germanium semiconductor counters. Electromagnetic transitions of 53.4, 79.7, 80.9, 160.6, 223.1, 276.5, 302.8, 356.2, and 383.7 keV were observed, and a level sequence of energies 80.9, 160.6, 383.7 and 437.1 keV was derived. The K-conversion coefficients for the above transitions were determined either by electron-gamma and gamma-gamma coincidences or by comparison of the intensities of the electron-conversion and gamma-ray peaks of the corresponding "singles" spectra; K/LM ratios are also determined. The electron-capture branching ratios to the four excited levels of ^{133}Cs as well as log ft values were derived. A decay scheme is proposed. (auth)

11964 SEARCH FOR THE INFLUENCE OF CHEMICAL BINDING ON THE HALF-LIFE OF $^{90m}Nb(T_{1/2} = 19.2$ sec). Weirauch, W.; Schmidt-Ott, W.-D.; Smend, F.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 209: 289-4(1968). (In German).

^{90m}Nb was produced by the reaction $^{90}Zr(d,2n)$. Comparison of its half-lives in two different chemical environments (Nb atoms in metallic Zr and in the niobium-fluoride complex) showed no difference greater than the experimental error of 1%, while Cooper et al. have reported that the half-life of ^{90m}Nb nuclei is shorter by 3.6% in metallic Nb than in the niobium-fluoride complex. In addition, the absolute value of the half-life of ^{90m}Nb in metallic Zr was determined to be $T_{1/2} = 19.2 \pm 0.3$ sec. (auth)

11965 ANOMALOUS K-CONVERSION COEFFICIENT OF THE 124-keV TRANSITION IN ^{131}Cs. Sen, S. K.; Rizvi, S. I. H.; Dohan, D. A. (Univ. of Manitoba, Winnipeg). Z. Phys., 209: 254-9(1968).

The absolute K-conversion coefficients of the 496 keV–124 keV cascade γ rays in ^{131}Cs were determined from angular correlation experiments using a new approach. The value of $\alpha_K = 0.0100 \pm 0.0007$ obtained for the 496-keV transition is in excellent agreement with the theory whereas a strong case is presented for the existence of an anomalous nuclear-structure-dependent conversion coefficient for the 124-keV transition. The K-conversion coefficient for this transition was measured to be 0.742 ± 0.077 giving a value of 1.25 ± 0.13 for the ratio $\alpha_K^{(expt)}/\alpha_K^{(theory)}$. The result is interpreted as being due to the presence of electric monopole (E0) electron transition. A value of 0.26 ± 0.14 was obtained for the E0/E2 electron conversion ratio and the absolute value of the electric monopole matrix element was determined to be 0.07 ± 0.02. (auth)

11966 MULTIPLE SCATTERING OF ELECTRONS IN THE ENERGY RANGE FROM 0.52 TO 2.0 MeV. Aiginger, H.; Wilmersdorf, G. (Oesterreichische Hochschule, Vienna). Z. Phys., 209: 260-75(1968). (In German).

The plural nuclear scattering of electrons with kinetic energies of 0.52 MeV up to 2.0 MeV was measured for angles between 0 and 20°. Pb, Ag, and Al foils of various thicknesses (mean number of collisions between 1 and 21) were used as targets. The experimentally derived angular distribution of the scattered electrons was compared with a numerical computation by Keil, Zeitler, and Zinn based on the Molière theory of plural and multiple scattering and his approximation of the single scattering law. His corrected values of the shielding angle and the mean number of collisions describe the distribution of the scattered electrons better than the original values derived from a Born-approximation calculation. The intensity of the remaining unscattered electrons must be calculated with the Born-approximation value for the mean number of collisions in order to obtain agreement with the experiment. (auth)

11967 INFLUENCE OF RADIATION DAMAGE IN SOLIDS ON NUCLEAR RESONANCE FLUORESCENCE YIELD OF THE 0.96-MeV LEVEL OF ^{152}Sm. Dutta, B. C.; Kalus, J.; Zahn, U. (Technische Hochschule, Munich). Radiochim. Acta, 7: 218(Aug. 1967). (In German).

The nuclear resonance fluorescence yield of the 0.96-MeV γ radiation of ^{152}Sm in scattering on Sm_2O_3 was measured on two sources. The ratio of the luminescence yield of the source without radiation damage to the source with damage was 1.051 ± 0.014. The experiment showed that the yield was reduced by radiation damage. The a value was increased by 1.20 ± 0.05 by the radiation damage. (J.S.R.)

11968 RECOIL RANGES OF 0.22- TO 5.2-MeV IONS IN VANADIUM, IRON, NICKEL, ZIRCONIUM, AND GOLD. Bowman, W. W.; Lanzafame, F. M.; Cline, C. K.; Yu, Yu-Wen; Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev., 165: 485-93(Jan. 10, 1968).

Recoil ranges were measured by the thick-target–thick-catcher technique for reactions induced in ^{51}V, ^{90}Zr, and ^{197}Au with 10- to 80-MeV ^4He ions, in ^{58}Ni with 2- to 21-MeV deuterons, and in ^{54}Fe with 15- to 60-MeV ^6Li ions. The experimental ranges ρ and ϵ were corrected for the influence of particle evaporation from moving fragments and for nuclear scattering. The corrected points are compared with the range theory of Lindhard, Scharff, and Schiott. Results of the comparison show agreement within experimental uncertainties over the entire range of measurement, covering values of ρ from 0.4 to 60 and ϵ from 0.13 to 40. (auth)

11969 NEW ISOTOPE ^{204}Au AND DECAY OF ^{202}Au. Ward, T. E.; Ihochi, H.; Karras, M.; Meason, J. L. (Univ. of Arkansas, Fayetteville). Contract AT(40-1)-3235. Phys. Rev., 164: 1545-7(Dec. 20, 1967).

Irradiation of ^{204}Hg with 14.8-MeV neutrons was found to produce a new radioactive nuclide which was assigned to ^{204}Au produced through the $^{204}Hg(n,p)^{204}Au$ reaction. The following radiation characteristics were observed to belong to the decay of ^{204}Au: half-life, 4.0 ± 1.0 sec; β endpoint energy 4.5 ± 0.3 MeV; γ-ray energy 0.43 ± 0.01 MeV. ^{202}Au was produced through the reactions $^{202}Hg(n,p)^{202}Au$ and $^{206}Tl(n,\alpha)^{202}Au$. The half-life of this nuclide was determined to be 30 ± 3 sec. The β endpoint energy of 3.5 ± 0.2 MeV and γ rays of 0.44 ± 0.01 and 0.52 ± 0.02 MeV were observed to belong to the decay of ^{202}Au. The relative intensities of γ rays were measured to be 100 and 2.5 ± 1, respectively. (auth)

11970 FISSION OF ^{241}Am BY THERMAL NEUTRONS. Hyakutake, Mikio (Kyushu Univ., Japan). Kyushu Daigaku Kogaku Shuho, 39: 170-6(Aug. 1966). (In Japanese).

To obtain preliminary data for studies of subthreshold fission of ^{241}Am and ^{237}Np, the fission fragment kinetic energies and fission cross section of ^{241}Am were measured, using the KUR reactor of Kyoto University. Values are reported on the fission cross section of ^{241}Am, induced by thermal neutrons. In the experiment a semiconductor counter was used to give good energy resolution. The kinetic energies of heavy and light fission fragments were found to be 75.5 ± 3.4 MeV and 107.8 ± 2.9 MeV, respectively. The average energy was 186 MeV, about 10 MeV larger than that calculated from Terrell's empirical equation. This discrepancy may

be partly due to the linearity of the circuits. The fission cross section obtained by comparing with ^{235}U was 3.8 ± 0.2 barns, somewhat larger than those by other workers. (NSA of Japan)

11971 THE (γ,α) PROCESSES ON NIOBIUM. Kraft, G.; Kosiek, R. (Univ., Heidelberg). Naturwissenschaften, 54: 337-8(1967). (In German).

In the irradiation of ^{93}Nb with 30.5-MeV bremsstrahlung, three maxima in the energy distribution of the α particles could be observed. The energy distribution curve was calculated by the statistical model, and the results were compared with the experimental results. The good agreement indicates that the greatest part of the (γ,α) process procedes by the evaporation process. (J.S.R.)

11972 HYPERFINE STRUCTURE IN THE LUTETIUM(III) SPECTRUM AND NUCLEAR MAGNETIC DIPOLE MOMENT OF ^{175}Lu. Heilig, K.; Kasten, P. (Technische Hochschule, Hanover). Naturwissenschaften, 54: 338(1967). (In German).

The hfs of Lu (III), especially the 2603.3 Å line, was measured using a photoelectrically recording Fabry–Perot spectrometer in order to determine the magnetic nuclear dipole moment of ^{175}Lu. The observed hfs of the line consists of two components of ^{175}Lu. A magnetic dipole moment $\mu_I(^{175}Lu) = 2.24 \pm 0.11\mu_K$ was determined from the hfs splitting. (J.S.R.)

11973 COMPARISON BETWEEN $^{139}La(\alpha,\gamma)^{143}Pr$ AND $^{142}Ce(p,\gamma)^{143}Pr$ NUCLEAR REACTIONS. Vassilacopoulou, Emma P. New York, Columbia University, 1964. 64p.

Thesis.

The excitation functions for the reactions $^{139}La(\alpha,\gamma)^{143}Pr$, $^{142}Ce(p,\gamma)^{143}Pr$, $^{139}La(\alpha,n)^{142}Pr$, and $^{142}Ce(p,n)^{142}Pr$ at excitation energies of 8 to 38 MeV were measured. The excitation function of the (α,γ) reaction rises to about 75 μb at 17-MeV excitation energy and falls to about 10 μb at 28-MeV excitation energy. The excitation function of the (p,γ) reaction rises to about 650 μb at 19 MeV and falls to about 80 μb at 36-MeV excitation energy. The large difference both in the shapes and in the magnitudes at the maxima of the two excitation functions, despite the fact that both reactions proceed through the same compound system, ^{143}Pr, is evidence for the direct contribution to the radiative capture of protons. A calculation of the (α,γ) excitation function based upon the compound-nucleus model agrees reasonably well with the experimental results. A calculation of the (p,γ) reaction within Lane and Lynn's direct-interaction formalism, although not in good agreement with the experimental results, gives a substantially better agreement than one within the compound-nucleus formalism. The (α,n) and (p,n) excitation functions both rise to a maximum of about 130 mb at 15 MeV and fall to around 10 mb at 38 MeV. The calculated cross sections according to the compound-nucleus mechanism are in reasonable agreement with the experimental results except at the high-energy end. (Disser. Abstr.)

11974 DECAY SCHEMES OF THE NEUTRON-RICH RARE EARTH NUCLIDES, ^{162}Tb, ^{164}Tb, ^{148}Pr, AND ^{145}Ce. Martin, Harold Rodney. Fayetteville, Ark., Univ. of Arkansas, 1967. 176p.

Thesis.

A 7.7 ± 0.3 min activity was assigned to ^{162}Tb. The ^{162}Tb decay scheme shows energy levels in ^{162}Dy at 81 ± 2, 266 ± 2, 888 ± 2, 963 ± 2, and 1148 ± 3 keV. An allowed-unhindered beta transition (1.3 ± 0.1 MeV, log ft = 5.0 ± 0.1) populates the 1148 keV level in 91 ± 3% of the ^{162}Tb decays. This beta transition strongly suggests that the ^{162}Tb ground state in terms of asymptotic quantum numbers is the I = 1−411−523 configuration and that the 1148 keV ^{162}Dy state has as the principal two-quasiproton contribution, the I = 2−411−523 configuration. No beta transition to the ground state was observed, within the experimental errors. Relative B(E2) values for gamma-ray transitions from the 888 keV gamma-vibrational band to the ground-state band were used to calculate a band-mixing parameter, z = 0.042. The observed intensity ratio for the (2- 82 keV 2+) and the (2- 888 keV 2+) transitions is in excellent agreement with the ratio predicted using the results of the band-mixing calculation. A half life of 3.0 ± 0.1 minutes has been assigned to ^{164}Tb. No evidence for the previously reported 23 hour activity for ^{164}Tb has been observed. Gamma-ray spectra taken following irradiation of ^{164}Dy revealed approximately 35 gamma rays with energies less than 2.0 MeV. Most of these gamma rays are assigned to ^{164}Tb. A partial decay scheme for ^{164}Tb with previously unobserved levels at 1590, 1673, and 2207 keV is presented. The available decay energy for ^{164}Tb was determined as 3.4 ± 0.2 MeV in good agreement with predictions from beta-decay systematics. Half lives of 2.8 ± 0.1 and 2.0 ± 0.1 min were determined for ^{145}Ce and ^{148}Pr, respectively. No evidence for the 12 min activity previously assigned to ^{148}Pr was observed. The total decay energies of ^{145}Ce and ^{148}Pr were measured as 2.6 ± 0.1 and 4.4 ± 0.2 MeV, respectively, which is in fair agreement with beta-decay systematics. The main beta-ray and gamma-ray transitions in ^{148}Pr are shown to be similar to those in ^{150}Pm. The levels proposed in ^{148}Nd are in substantial agreement with levels found in recent investigations by means of Coulomb excitation. Although the energy levels in ^{145}Pr should be similar to those of ^{143}Pr, the main beta-ray transitions from ^{145}Ce are shown to be quite different from those from ^{143}Ce. This may indicate the existence of low-lying negative parity states in ^{145}Pr, or that the ground-state spin of ^{145}Ce is different from that of ^{143}Ce. (Disser. Abstr.)

11975 STUDY OF THE $^{209}Bi(\gamma,\pi^-xn)^{209-x}Po$ AND $^{206}Pb(^3He,xn)^{209-x}Po$ REACTIONS BY DETECTION OF POLONIUM ALPHA ACTIVITIES. Grike, Leo Joseph Jr. Urbana, Ill., Univ. of Illinois, 1967. 212p.

Thesis.

The cross sections for the reactions $^{209}Bi(\gamma,\pi^-xn)^{209-x}Po$ were measured for x = 0 to 3, 5, and 7 and were used to estimate the total (γ,π^-) cross section. Total (γ,π^-) cross sections have not previously been measured for a complex nucleus. At bremsstrahlung energies of 200, 220, and 250 MeV, the total cross sections are 0.7, 2.8, and 8.9 mb, respectively. These are 6.5, 24, and 65 times the CGLN cross sections for (γ,π^-) on free neutrons. This result disagrees with both surface production and volume production models. At all energies, the cross section for x = 2 dominates. This cannot be simply explained in terms of the free neutron cross sections. It is suggested that this experiment may be preferentially exciting isobaric analogs in ^{209}Po of the lower excited states in ^{209}Bi. The cross sections for $^{206}Pb(^3He,xn)^{209-x}Po$ were measured in the range 18 MeV ≤ E(^{3}He) ≤ 27 MeV. They were found to be much smaller than the equivalent ^{4}He cross sections. A new evaluation of data already in the literature yielded an alpha branching ratio of 2.6×10^{-4} for ^{207}Po. (Disser. Abstr.)

11976 NUCLEAR LEVEL STRUCTURE OF ^{149}Pm AND ^{151}Sm. Chen, Chia-hwa. Buffalo, State Univ. of New York, 1964. 103p.

Thesis.

The gamma rays following the beta decay of ^{149}Nd and ^{151}Pm were studied using fast-slow coincidence techniques. A scintillation coincidence spectrometer, with a resolving time close to 50 millimicroseconds, was built and used for this investigation. In the decay of ^{149}Nd, 21 gamma rays were identified. Levels are established in ^{149}Pm at 112, 114, 189, 210, 265, 387, 535, 650, and 750 keV. The gamma-gamma directional correlation was measured for the 270-kev—265-keV cascade. The expansion coefficients were found to be $A_2 = -(0.224 \pm 0.014)$ and $A_4 = 0$. The interpretations of the directional correlation data were made graphically and the possible spin sequences were tabulated. The relative intensities of the gamma rays and the X-ray were estimated from the singles and the coincidence spectra. A level scheme of ^{149}Pm is proposed. In the decay of ^{151}Pm, the coincidence measurements were in good agreement with the decay scheme previously known from the conversion measurements. A new level at 946 keV and 8 weak gamma rays are added in the level scheme of ^{151}Sm. Directional correlations were measured for the 275-keV—65-keV and 240-keV—100 keV cascades. The expansion coefficients were found to be $A_2 = 0.087 \pm 0.012$ for the former and $A_2 = 0.067 \pm 0.008$ for the latter. ($A_4 = 0$ for both cascades within the experimental error.) The possible spin sequences are tabulated. The interpretation of the level structure is made using the Nilsson model which has been successful in the analysis of the level structure for the nuclei in the region 153 < A < 185 as well as other regions where the nuclei possess large axially symmetric deformations. The agreement between this model and the proposed level structure is somewhat limited. In the region of present investigation, a sharp decrease in nuclear deformation is very likely and the deviation from axially symmetric deformation is quite evident. (Disser. Abstr.)

11977 THEORETICAL INVESTIGATIONS OF SEVERAL ODD MASS NUCLEI BY THE INTERMEDIATE COUPLING APPROACH IN THE UNIFIED NUCLEAR MODEL. O'Dwyer, Terry F. Brooklyn, Polytechnic Inst. of Brooklyn, 1967. 128p.

Thesis.

A theoretical investigation is made of the experimental data available on the low-energy properties of odd-mass promethium and iodine nuclei using the intermediate coupling approach in the unified nuclear model. Within this approach it is assumed that the last odd nucleon, in the present work a proton, is coupled to the quadrupole-type surface oscillations of the even-even core. In the case of promethium, the even-mass neodymium nuclei form the cores while the even-mass tellurium nuclei form the iodine cores. The last odd proton in the promethium isotopes is considered to move in the $1g_{\frac{7}{2}}$ and $2d_{\frac{5}{2}}$ orbits, while the last odd proton in the iodine isotopes is considered to move in the $1g_{\frac{7}{2}}$, $2d_{\frac{5}{2}}$ and $2d_{\frac{3}{2}}$ orbits.

The parameters which enter into the calculations are the phonon energy, $\hbar\omega$, the coupling parameter, ξ, and the effective single-particle spacing ϵ. The value of $\hbar\omega$ is inferred from the experimentally observed energy of the first excited 2^+ state of the even-even core. The other parameters are determined by obtaining the best fit to the observed energy spectra while staying within the limits imposed by physical considerations. The Hamiltonian matrix is diagonalized in the space of the uncoupled system for values of spin from $\frac{1}{2}$ to $\frac{11}{2}$. Using physically reasonable values of the effective spacing between single-particle states, and the strength of the coupling between the extra proton and the collective oscillations of the core, the energy, spin and parity of the low-lying states of ^{149}Pm, ^{147}Pm, ^{145}Pm, ^{131}I, ^{129}I, and ^{127}I are calculated. The theoretical results are in reasonably good agreement with the available experimental data. In addition to the energy levels, the electromagnetic transition probabilities are calculated using the eigenfunctions obtained from the diagonalization of the Hamiltonian matrices. In most cases there is good agreement between the calculated and observed lifetimes and in almost all cases the multipole order and type of the transition predicted is consistent with the available experimental data. The results for the nuclear moments are less encouraging although semi-quantitative agreement between theory and experiment is still obtained. Finally, a discussion is given of the parameters used in the present analysis and how reduction factors based on occupation numbers would affect the coupling stength, ξ, and the deformation parameter, β. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 11694, 11871, 11907, 11908, 11919, 11933, 11944, 11953, and 11977.

11978 (HMI-B-51) NEUERE ENTWICKLUNGEN IN DER THEORIE DER KERNREAKTIONEN. (New Developments in the Theory of Nuclear Reactions). Eichler, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Mar. 1967. 221p. (In German). Dep.

The latest developments in the theory of nuclear reactions are reviewed and critically analyzed. The theory of stripping reactions, nuclear structure and spectroscopic factors, inelastic effects and internal excitation, two-nucleon transfer, Feshbach theory of nuclear reactions, application of the Feshbach's theory to the elastic scattering of neutrons and to the nuclear photoeffect, neutron force functions, pairing and quasiparticles, model calculation for neutron widths and force functions, and the isobaric analog states are discussed. (J.S.R.)

11979 (IPNO/TH-100) RETARDED INTERACTIONS IN FERMI SYSTEMS. Dover, C. B. (Massachusetts Inst. of Tech., Cambridge); Lemmer, R. H. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). July 1967. 68p. Dep.

The nature of the two-body interactions in many fermion systems is studied from the viewpoint of meson theory. An exactly soluble model is formulated for linear coupling of a meson field to fermion density fluctuations, in which meson degrees of freedom are treated exactly, and fermion motion within the domain of the random phase approximation (RPA). Instability conditions for the RPA ground state are established. More generally, the effective two-body interaction is deduced via a Green's function technique by eliminating the meson degrees of freedom. This interaction is shown to be frequency dependent, i.e. retarded in time. The resulting interaction is then applied to the calculation of the Hartree–Fock field and the collective modes of the system via a generalized Landau equation. In the H.F. approximation, one obtains an unambiguous separation of renormalization (self-energy) effects and the nucleon–nucleon interactions themselves, the former reducing to the correct mass renormalization of the nucleon in the static limit. For reasonably small momenta ($p < p_F$), the retardation corrections to the H.F. field can be characterized by a small parameter (G_F/μ^2) ($\approx .1$ for actual nuclear densities), where G_F = Fermi energy and μ = meson mass. The corrections become more important at high momenta and densities. In the long-wavelength limit, the frequency dependent corrections to the collective mode energies are found to be of order $(\omega/\mu)^2$, where ω = collective mode energy. For a static Yukawa interaction, a value $\lambda^2 \approx 5$ (consistent with the usual shell model values) is found for the neutral scalar coupling constant by requiring that the giant dipole collective state appear at the experimental energy. For pseudoscalar coupling, the usual renormalized coupling constant $f^2/4\pi \approx 0.08$ is shown to yield a "breathing mode" in heavy nuclei consistent with crude estimates based on nuclear compressibilities. (auth)

11980 (UCLA-10P18-4) RESEARCH PROGRAM OF THE UCLA CYCLOTRON LABORATORY. Report AR2. Richardson, J. Reginald; Wright, Byron T. (California Univ., Los Angeles. Dept. of Physics). July 1967. Contracts N00014-67-A-0009; AT-11-1-GEN-10. 131p. Dep. CFSTI.

The Nuclear Consortium, expansion of the cyclotron laboratory, and cyclotron and laboratory operations are discussed. The research covered experiments on nucleon reactions with nuclei for the study of bremsstrahlung, cross sections, elastic scattering, correlation spectra, angular distribution, polarization, and spectroscopy. Theoretical studies were few-nucleon problems, optical mode analysis, distorted wave theory, and proton dosimetry. A description of the computer is also given. (J.F.P.)

11981 VELOCITY-DEPENDENT NUCLEON–NUCLEON POTENTIAL AND NUCLEAR MAGNETIC MOMENTS. Dzhibuti, R. I. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 47: 31-5(July 1967). (In Russian).

Data obtained on the velocity-dependent potential and nuclear magnetic moments showed that in contrast to the repulsive core in the nucleon–nucleon interaction potential, which does not affect magnetic nuclear moments, the velocity-dependent potential induced additional magnetic moments. The calculation of the additional magnetic moment is only of qualitative character because it was calculated for only one pair in a singlet spinor state and is based on a series of approximations. It should be calculated within the model of independent pairs so that the corrections for the ^{209}Bi magnetic moment calculated by R. K. Bhadure et al. (Phys. Rev., 20: 182(1966)) produced a magnitude of 0.55 nm. (R.V.J.)

11982 RESONANCE PARAMETERS IN THE CASE OF POTENTIAL WITH A STRONGLY DIFFUSE BOUNDARY. Sergeev, V. A. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 229-33(Feb. 1967). (In Russian).

In the case of light nuclei the concept of a sharp nuclear interaction boundary creates a problem as to the physical sense of the parameters obtained in processing experimental data with the aid of the R-matrix theory formulas. This problem is considered using the example of a strongly diffuse potential well for which an analytical solution exists at $l = 0$. It is shown that at reasonable channel radius values the s-resonance parameters obtained by the usual R-matrix theory may be arbitrary. The proposed model enables accurate separation of the external from internal contribution by means of rigorous expressions for potential phase, penetrability, and shift. (JPRS)

11983 NONRADIATIVE NUCLEON TRANSITIONS IN NUCLEAR FISSION. Cherdantsev, P. A.; Marshalkin, V. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 234-7(Feb. 1967). (In Russian).

The results of calculations carried out within the framework of the shell model have given nucleon pairing energies for uniform nucleons which are in good agreement with those computed from semi-empirical formulas. The identical nucleon pairing energies (C_n = 12.3 MeV; C_p = 7.8 MeV) are given for Te, Pb, and Xe isotopes. It is shown that a fundamental effect on the probability of nonradiative nucleon transition is exerted by strong changes in the rate of deformation. (JPRS)

11984 PROBLEM OF TWO EXTRA NUCLEONS AS A SPECIAL CASE OF THE THREE-BODY PROBLEM. Zhmailo, V. A.; Gornatko, C. N.; Zhikhareva, S. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 238-44(Feb. 1967). (In Russian).

A nucleus with two nucleons outside the closed shells can be regarded with good accuracy as a three-body system. The method of Baz is used to consider a system consisting of two particles moving in a potential of the rectangular well type in an attempt to study, with the aid of the above model, the qualitative features of the energy spectrum of appropriate nuclei. A comparison with the external field-harmonic oscillator approximation is made. (JPRS)

11985 STATISTICAL AND NONSTATISTICAL PROCESSES OF FRAGMENT FORMATION BY HIGH-ENERGY PARTICLES. Lozhkin, O. V.; Yakovlev, Yu. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 315-22(Feb. 1967). (In Russian).

The values of $Q(n,\alpha)$ reaction and potential barrier penetrability for α particles from the (n,α) reaction on a large number of radioactive and some stable nuclei are given. The $Q(n,\alpha)$ values were calculated for relatively stable nuclei ($T_{\frac{1}{2}} > 24$ hr) from the mass difference before and after reaction using new nuclide mass tables. (JPRS)

11986 LEVEL DENSITY PARAMETER VALUES FROM NEUTRON AND PROTON RESONANCES. Facchini, U.; Saetta-Menichella, E. (CISE Labs., Milan. Univ., Milan). Energ. Nucl. (Milan), 15: 30-8(Jan. 1968).

Slow neutron resonances, which are now known for a larger number of nuclei and with greater accuracy than in the past, were

analyzed to obtain values of the level density parameter a. Resonances by (p,γ) reactions were also considered for 8 light nuclei. The analysis was performed considering the level density formula given by the equidistant spacing model. The values of the parameter a, which are presented for a total of 197 nuclei, show an increasing trend versus the mass number A, with strong oscillations around a linear trend. Particularly, marked minima are found in the region of the nuclei having a magic number of neutrons. The values of a were then compared with those obtained by Strutinsky with an average of the various shell levels of Nilsson model. The agreement proved to be satisfactory. (auth)

11987 ANGULAR CORRELATIONS IN RADIATIVE MUON CAPTURE. Oziewicz, Z.; Pikulski, A. (Univ., Wroclaw). Acta Phys. Pol., 32: 873-85(Dec. 1967).

The angular correlation in the reaction $\mu^- + (A,Z) \rightarrow (A,Z-1)^* + \nu_\mu \rightarrow (A,Z-1) + \gamma + \nu_\mu$ between the polarization pseudovector of the muon, the direction of the neutrino momentum, the direction of the gamma quantum momentum and its circular polarization are calculated. The exact formulas are given for the allowed transitions and the first and second forbidden transitions. It is shown that for the unique transitions some correlation constants depend very strongly on the induced pseudoscalar term and are almost independent of the nuclear structure. The results of numerical calculations are presented for some unique transitions. (auth)

11988 NUCLEAR SHELL STRUCTURE FOR TRAPEZOIDAL AND MODIFIED GAUSSIAN RADIAL DENSITY. Nowak, W. (Univ., Lodz, Poland). Acta Phys. Pol., 32: 697-703(Nov. 1967).

The nuclear shell structure for trapezoidal and modified Gaussian density is discussed. There is a comparison of the theoretical numbers of proton and neutron for a given l with corresponding theoretical and experimental values. The comparison shows that the trapezoidal radial density gives a good explanation of the nuclear shell structure. (auth)

11989 INFLUENCE OF NONLINEAR SURFACE VIBRATIONS ON THE DENSITY DISTRIBUTION IN NUCLEI ACCORDING TO THE HYDRODYNAMIC MODEL. Grauel, A. (Technische Hochschule, Darmstadt, Ger.); Scheid, W. Z. Phys., 209: 188-96 (1968). (In German).

The cubic terms in the Hamiltonian of the oscillating surface are eliminated by a canonical transformation. The expectation value of the density in the ground state, the mean radius in the one-surfon state, and the transition density are calculated in a higher approximation. (auth)

11990 NUCLEAR FORCES. PART I. NUCLEAR FORCE IN DYNAMICAL REGION. Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 1-346(1967).

Separate abstracts were written for the 6 individual papers in this review. (S.F.L.)

For abstracts of individual papers see: 11991–11996.

11991 OUR HISTORY AND THE UNDERLYING PHILOSOPHY OF JAPANESE STUDIES ON NUCLEAR FORCES. Taketani, Mituo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 1-22(1967).

The history and philosophy of research activities in Japan on the nuclear force are reviewed. (S.F.L.)

11992 POTENTIAL MODEL APPROACH. Tamagaki, Ryozo (Hokkaido Univ., Sapporo); Watari, Wataro. Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 23-90(1967).

The potential model approach to nuclear theory is reviewed. Topics discussed are: nonlocality and nonstatic terms in the potential; form of the potential; experimental data on the effective range parameters; quantitative properties of the singlet even central potential; the pion–nucleon coupling constant; nonstatic effects in the singlet even state; main features of phase shifts; triplet P wave at very low energies; nonstatic potentials in the triplet odd state; triplet P wave phase shift at intermediate energies; core region in the triplet odd state; the deuteron problem; triplet even scattering at high energies; the singlet odd state; and matrix elements of noncentral operators. (S.F.L.)

11993 NONSTATIC NUCLEAR POTENTIAL. Machida, Shigeru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 91-139(1967).

The nonstatic effects of nuclear forces are reviewed. Topics discussed are: general form of the nuclear potential in the momentum representation; integral equations in momentum space and phase shifts; matrix elements of potential in momentum space; one-pion exchange potential; phase shifts in the Born approximation; solution of the integral equation in momentum space; derivation of the nonstatic one-pion exchange potential (OPEP); rigorous derivation of the nonstatic OPEP; detailed properties of the nonstatic OPEP; derivation of the nonstatic two-pion exchange potential (TPEP); results for TPEP up to the first order of the M^{-1} expansion; results with full recoil; validity of the q/M expansion and the nonstatic TPEP in x space; effects of nucleon pair diagrams; and general features of the nonstatic TPEP. (S.F.L.)

11994 ONE-BOSON-EXCHANGE MODEL. Ogawa, Shuzo (Hiroshima Univ.); Sawada, Shoji; Ueda, Tamotsu; Watari, Wataro; Yonezawa, Minoru. Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 140-89(1967).

The one-boson-exchange model is reviewed. Topics discussed are: the Sakata model and the one-hadron-exchange model; nuclear force in the one-boson-exchange model; assumptions of the one-hadron-exchange-contribution model; calculation of the one-boson exchange contribution; comparison of the one-boson-exchange-contribution model with experimental data; non-static effects involved in the one-boson-exchange contribution; the one-boson-exchange potential; experimental evidence for the mesons required by the one-boson-exchange model, including scalar mesons, pseudoscalar mesons, vector mesons, and other types of mesons; the one-boson-exchange-contribution model of high energy nucleon–nucleon collisions; and problems of the one-boson-exchange model. (S.F.L.)

11995 DISPERSION THEORETIC APPROACH. Furuichi, Susumu (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 190-285(1967).

The dispersion theoretic approach to nuclear forces is reviewed. Topics discussed are: the dispersion relation for N–N scattering in the early period; how to apply the dispersion relation to N–N scattering; foundations of the partial-wave dispersion relation and the Mandelstam representation; application of the partial-wave dispersion relation to the evaluation of the two-pion-exchange contribution; spectral representations for N–N scattering in the neutral spinless model; structure of the $G_{N\bar{N}}$ and N–N dispersion relations; structure of the partial-wave dispersion relation and the "proper" 2π contribution; energy dependence of the two-pion-exchange contributions in the neutral spinless model; properties of the right-hand cut and solution of the partial-wave dispersion relation; kinematics of the N–N system; realistic N–N scattering; two-pion exchange contribution without pion-pion correlation; comparison of two-pion-exchange with one-boson-exchange and with empirical phase shifts; pion-pion correlation effects in the two-pion-exchange contribution; effect of higher π–N resonances; analytic continuation of $\mathrm{Im}A(s_i,t)$ and $\mathrm{Im}B(s_i,t)$; and application of partial-wave dispersion relation as a dynamical equation and to the S-wave amplitudes. (S.F.L.)

11996 PRESENT STATUS OF EXPERIMENTAL STUDY OF NUCLEON–NUCLEON SCATTERING. Nisimura, Keigo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. No. 39, 287-346 (1967).

A survey is presented of the present status of experimental information on nucleon–nucleon scattering. Investigations being carried out on proton-proton scattering at 50 MeV are reviewed. (S.F.L.)

11997 TIME-DEPENDENT SCATTERING THEORY FOR SINGULAR POTENTIALS. Hunziker, W. (Eidgenossische Technische Hochschule, Zurich). Helv. Phys. Acta, 40: 1052-62(Dec. 30, 1967).

Scattering states are constructed for nonrelativistic, multiparticle systems with singular potentials. The case of hard-core potentials provides a simple example of a system whose Hilbert space is not simply defined by the kinematical structure, but also by the interactions. This leads to a modification of the usual scattering formalism and of the notion of asymptotic observables; quantitites like the momenta of single particles are not observables of the system, but are still defined as asymptotic observables. (auth)

11998 A NONRELATIVISTIC FORMULA FOR CALCULATING DOPPLER BROADENING IN TWO-BODY COLLISIONS. Smith, D. L. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 58: 315-17 (Jan. 1968).

A nonrelativistic formula for calculating the Doppler (kinematic) broadening of the energies of groups of atomic or nuclear particles emitted in two-body collisions is derived. This formula is a third-order expansion in the small angular deviations from the mean direction of emission of the observed particles. The relative importance of the first-, second- and third-order terms in this expansion is considered for three representative examples. (auth)

11999 ALPHA-PARTICLE MODEL FOR NUCLEAR MATTER. Khanna, K. M. (Dibrugarh Univ., India). J. Phys. Soc. Jap., 23: 1429(Dec. 1967).

A realistic calculation of the normal-superfluid phase transition temperature of an extended system of alpha particles is presented for densities less than that corresponding to nuclear saturation. (D.C.W.)

12000 TRANSITORY BEHAVIOR OF A PACKET OF WAVES SCATTERED BY A SQUARE-WELL POTENTIAL. Jeukenne, J. P. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 418-30 (1967). (In French).

The evolution in space and time of the wave packet associated with slow neutrons elastically scattered by a nucleus is analyzed using the formal solutions of the time-dependent Schroedinger equation obtained in a previous paper, the scattering interaction being approximated by a square-well potential. The role of the different poles of the S-matrix in the formation and decay of the compound nucleus is discussed. (auth)

12001 REZONANSNOE RASSEYANIE GAMMA-LUCHEI NA YADRAKH. (Resonance Scattering of Gamma-Rays on Nuclei). Kaipov, D. K. Alma-Ata, USSR, Izdatel'stvo Nauka, 1967. 148p.

A brief review is given on the resonance γ-ray scattering on nuclei and determination of the half-life of nuclear excited states. The general method for calculating the γ ray microspectrum, based on function distribution theory is described and generalized for condensed media considering the recoil in atom collisions. The nuclear recoil delay is analyzed from the point of view of continuous and discrete collisions. The results of experimental studies of the resonance γ ray scattering on the nuclear levels are discussed and the data obtained are compared with the theoretical concepts. 191 references included. (R.V.J.)

12002 RADIATIVE CORRECTIONS TO NEUTRON BETA DECAY. Rabitz, Ronald. New York, New York University, 1967. 236p.

Thesis.

The second-order electromagnetic radiative corrections to the Fermi rate for neutron beta decay were calculated in a gauge-invariant manner using several models. In the first calculation, the nucleons are regarded as point particles and a cutoff function $\Lambda^2/(\Lambda^2 - k^2)$ is introduced in the integrals. In a second calculation, the electromagnetic structure of the proton is approximately described by charge form factors. These form factors were obtained from data recently published by the Cambridge and Stanford groups. It was found that the use of these charge form factors for the proton gave corrections to the uncorrected Fermi rate which are quite similar to those obtained in the point structure calculation. For example, a correction of 1.47% when the Cambridge form factors are employed, and a correction of 1.50% when the Stanford form factors are used, for the case of the endpoint energy of ^{14}O decay. It is pointed out that the Cambridge form factors do not contain "core" terms and, consequently when they are used there are no ultraviolet divergences in the calculation. A calculation of the second-order electromagnetic radiative effects due to the anomalous magnetic moments of the nucleons has also been made. In this calculation, the cutoff function $\Lambda^2/(\Lambda^2 - k^2)$ was taken to describe approximately the electromagnetic structure of the nucleons. The corrections due to the anomalous magnetic moments of the nucleons were evaluated at a value of Λ^2 determined by fitting the cutoff function $\Lambda^2/(\Lambda^2 - k^2)$, by a least square procedure, to the published data of the Cambridge and Stanford groups. It is found, as a good estimate, that the anomalous magnetic moments of the nucleons give a correction of -0.18% to the uncorrected Fermi rate. This correction is combined with the appropriate one due solely to the charge corrections; and in total, a correction of 1.28% to the uncorrected Fermi rate is obtained. Thus, the effects of the anomalous magnetic moments of the nucleons have not significantly altered the point structure calculation results. A new calculation is then performed by employing a rough model, in the framework of the conserved vector current theory, which takes into account the structure effects at the weak interaction vertex. Although the model is not very realistic, it is found that it presents some interesting features. For example, in this model one is able to compute the second-order electromagnetic radiative corrections. Also, it is found that in order to maintain gauge invariance, the effects of photons emitted at the weak interaction vertex must be included in addition to the usual Feynman diagrams. It is found that this model leads to a correction of 1.17% to the uncorrected Fermi rate. In the various calculations, the universal term is unaltered and arises in the same manner as it did in the point structure calculation. By using radiative corrections evaluated at the endpoint energy of ^{14}O decay, it is found that the vector coupling constant of beta decay G_v lies in the range $1.4043 \pm 0.0022 \times 10^{-49}$ erg cm$^3 \leq G_v \leq 1.4066 \pm 0.0022 \times 10^{-49}$ erg cm^3, depending upon the particular model used in the electromagnetic radiative corrections. The new principle of universality $G\mu \cos\theta = G_v$, which was recently proposed by Cabibbo to determine the angle θ, is then employed. It is found that θ lies in the range $0.199 \leq \theta \leq 0.207$, depending upon the model which we have employed in our electromagnetic radiative corrections. (Disser. Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 10375, 10437, 10438, 10524, 10903, 10904, 11007, 11023, 11037, 11072, and 11087.

12003 (AE-306) FINAL REPORT ON IFA-10, THE SWEDISH INSTRUMENTED FUEL ASSEMBLY IRRADIATED IN HBWR, NORWAY. Gyllander, J-A. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Dec. 1967. 36p. Dep.

A final report is given on IFA-10, the first Swedish instrumented fuel assembly irradiated in HBWR. The post-irradiation data are presented and correlated with the irradiation statistics. No bowing of the bundle was observed, no equi-axed grain growth was discernible, the fission gas release was very small, and the relative dimensional changes in length and diameter were of the order of magnitude 9×10^{-4}. The hydride content of the can increased from 35 ppM to 65 ppM and, in the contact point of the spacer, to 180 ppM. (auth)

12004 (AECL-2790) CANADIAN VIEW OF THE NATURAL URANIUM HEAVY WATER POWER REACTOR TODAY. Foster, J. S. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). Nov. 1967. 18p. Dep. CFSTI. CAN.

The estimated initial fuelling cost for the 500 MW(e) Pickering Power Reactor is discussed. This is compared with the initial fuelling cost for light water reactors. The economics and initial capital investment of both heavy water and light water reactors are compared. Operating experience for the NPD, Douglas Point, Gentilly, and the organic-cooled WR-1 are outlined. (M.L.S.)

12005 (ANL-7379) PROTOTYPE PORTABLE PUMP AND OXIDE-CLEANUP SYSTEM FOR EBR-II ROTATING SHIELD PLUG SEALS. Elias, P.; Goldfuss, G. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

One of the post-shutdown operational problems existing in the EBR-II is the occasional sticking of two, motor-driven, rotating shield plugs preparatory to exchange of fuel or insertion of irradiation test specimens. Investigations indicate the cause of plug sticking is the accumulation of oxidic material in the Bi-Sn alloy rotary freeze seal on each plug. Descriptions are presented for: (1) the measures used to reduce oxidation of the seal alloy, (2) the manual techniques used periodically for batch-type removal of accumulated oxidic material, and (3) the prototype, portable pump and cleanup system designed to expedite removal of this material. Also included are the results of feasibility tests of the prototype system under simulated operating conditions. (H.D.R.)

12006 (ANL-7399) REACTOR DEVELOPMENT PROGRAM, Progress Report, November 1967. (Argonne National Lab., Ill.). Dec. 28, 1967. Contract W-31-109-eng-38. 172p. Dep. CFSTI.

REACTOR FUEL ELEMENTS—radiation effects on uranium-plutonium-zirconium, postirradiation analyses of; radiation effects on carbide, summary of; carbon analysis for uranium oxide (UO_2) plate-type; dimensional measurements of, summary of postirradiation; reactivity defect calculations for EBR-2 subassemblies of; swelling of Mark-IA, effects of pressure on; nondestructive testing of EBR-2 irradiated; bond-testing of EBR-2 irradiated

URANIUM ALLOYS, PLUTONIUM ALLOYS, ZIRCONIUM ALLOYS—Pu-U-Zr, radiation effects on, postirradiation analyses of

URANIUM PHOSPHIDES—interaction between jacketing alloys and

URANIUM CARBIDES—preparation of fast reactor fuels of, techniques for

REACTORS, FAST—fuels for, preparation techniques for carbide; dynamics calculations for, development of computer codes for

VANADIUM ALLOYS—cladding materials of, mechanical properties of fuel

VANADIUM ALLOYS, CHROMIUM ALLOYS, TITANIUM ALLOYS—Cr-Ti-V, mechanical properties of, effects of neutron influence and temperature on

CRITICAL ASSEMBLIES—reactivity measurements for small sample perturbations in ZPR-3 fast; core material samples for ZPR-3 Assembly 50 fast, specifications for; mockup of FFTF in ZPR-3, composition of core for; atomic concentrations of ZPR-9 assemblies 19-21; reactivity worths of FFTF safety rods in ZPR-3, calculation of

BORON, TANTALUM—reactivity worth as a function of size

URANIUM—reactivity worth of depleted, effects of size on

FAST FLUX TEST FACILITY—nuclear mockup in ZPR-3 of, core composition of

MAGNETIC MATERIALS—thermal and mechanical testing of

EXPERIMENTAL BREEDER REACTOR-II—power-reactivity decrement measurements in; transfer function measurements in; control rods for, use of rod drop techniques for calibration of stainless steel; fuel element subassemblies of, reactivity defect calculations for; sodium coolant for, determination of bismuth and tin concentration in; test facilities in EBR-2, tabular summary of experiments in; structural materials for, radiation effects on; fuel elements for, mechanical testing of cladding for; fuel cycle facility for, production summary

REACTOR CONTROL ELEMENTS—calibration of EBR-II stainless steel, use of rod drop technique for

SODIUM—cesium separation from, effects of physical conditions on; impurities in, chemical analysis for bismuth and tin; corrosion inhibition in liquid use of dissolved getters for

CESIUM—separation from sodium, effects of physical conditions on

BISMUTH, TIN—content in sodium, chemical determination of

SUPERHEATERS—tubes for, eigenvalues and natural frequencies of

MOLYBDENUM—use as burnup monitor for uranium oxide fuels, feasibility of

REACTOR FUELS—burnup monitor for uranium oxide, possible use of molybdenum as; sintering of oxide, effects of atmospheric conditions on; stoichiometric properties of oxide, comparisons of; pyrochemical processes for fast oxide breeder, development of; meltdown studies in TREAT; fragmentation of metallic, dynamics of

REACTOR FUEL ELEMENTS—cladding for EBR-2, mechanical testing of

URANIUM OXIDES UO_2, PLUTONIUM OXIDES PuO_2—PuO_2-UO_2, fuel pins of, electron microprobe analysis of irradiated

PLUTONIUM—separation from spent fuel, use of fluoride volatility process for

RUTHENIUM—separation from plutonium using fluoride chemistry for

ARGONNE ADVANCED RESEARCH REACTOR—beryllium reflector for, heat transfer analysis of

REACTOR SAFETY EXPERIMENTS—fuel meltdown studies in TREAT, ceramic; sodium loop experiments in TREAT, analysis of metallic fuel meltdown in

GALLIUM—fragmentation of, thermal effects on

FLUORIDE VOLATILITY PROCESSES—use for separation of plutonium from ruthenium (M.L.S.)

12007 (APDA-CFE-2) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 2, September 1966. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Feb. 1967. Contract AT(11-1)-865. 37p. Dep. CFSTI.

A detailed operations history, through September 1966 for the Fermi Fast Breeder Reactor, is given. Changes in reactor fuel loading during May, June, July, and September are listed. The first indication of higher than calculated outlet temperatures for some subassemblies are indicated in the September entry. Complete and detailed loading diagrams, dated 9/16/66, 9/22/66, 9/23/66, and 9/27/66, are shown. September 1966 operating data for the sodium and gas systems are presented. Safety rod delatching, and associated scrams are discussed. Modifications to the steam generator Na outlet-temperature instrumentation and control system are described. Fuel handling equipment modifications are tabulated; weld leaks in the steam generators are described; radiation monitor malfunctions are listed. Results of nuclear and plant test programs are discussed. Maintenance of and additions to the various Fermi systems are described. (M.L.S.)

12008 (BNWL-537) NUCLEAR SAFETY QUARTERLY REPORT, APRIL-JUNE 1967 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. Albaugh, F. W.; Fuquay, J. J.; Harty, H.; Volland, E. E.; Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT-(45-1)-1830. 54p. Dep. CFSTI.

CONTAINMENT SYSTEMS EXPERIMENT—containment vessel for, leak rate testing of; fission product aerosol transport in, testing of; blowdown tests in, adequacy of instrumentation during

REACTORS — piping for, use of acoustical emission for crack detection in pressure; effluent disposal into soil systems
SEDIMENTATION — radioisotopic analysis of Columbia River
AEROSOLS — transport in reactor containment systems, measurements of
IODINE — reactions with organic paints
REACTORS, BOILING — blowdown parameter measurements for, tabular summary of CSE
IODIDES — removal from containment systems of organic, use of reactive sprays for
METHANE — IODO, reaction rate constants for
ACOUSTIC WAVES — use for crack detection in reactor pressure piping (M.L.S.)

12009 (BNWL-602) FOREIGN TRIP REPORT. Finch, L. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 51p. Dep. CFSTI.

A trip report on a visit to foreign sites involved in fast reactor technology is given. This trip was for the purpose of providing information on sodium reactor technology which might be of use in the FFTF. Sites visited were Dounreay Fast Reactor at Thurso, Scotland; Risley, England, where the principal engineering and development work for the Prototype Fast Reactor (PFR) is being performed; the BR-2, a thermal reactor with skewed core geometry at Mol-Donk, Belgium; Karlsruhe, Germany, where the conceptual work for the German sodium cooled fast reactor is being done; and Rapsodie at Cadarache, France. Observations, notes, and data are given. (M.L.S.)

12010 (CEA-R-3318) ETUDE NEUTRONIQUE D'UN COEUR A EAU LEGERE REFLECHI PAR DE L'EAU LOURDE. (Neutronic Study of a Light Water Core Reflected with Heavy Water). Golinelli, Claude; Tellier, Henry (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1967. 104p. (In French). Dep.

In designing a high flux reactor with extracted beams an experimental study was made on a light water and highly enriched uranium core surrounded by a thick heavy water reflector. The experimental study included: criticality measurements for various core geometries; measurement of void and temperature coefficients; distribution of neutron density and fission sources; study of kinetic parameters and calibration of control elements; and measurements of spectral indices and of flux perturbations due to the presence in the reflector of channels for the neutron beam extraction. Analysis of the experimental results shows a satisfactory agreement with calculations and that in some cases better hypotheses should be taken. (auth)

12011 (CEND-294) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF PEACH BOTTOM CORE I. Kern, Richard; Shesler, Albert T. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Mar. 13, 1967. Contract AT(38-1)-428. 54p. Dep. CFSTI.

Determination of heavy-isotope content in Peach Bottom, Unit I, Core I is effected by use of the ISOCHECK method. Necessary distortions of the reactor geometry because of core loading pattern and large number of fuel elements are discussed. Accuracies of ±12% for ^{233}U, ±9% for ^{235}U, and ±9% for total fissile uranium content are reported. The physics analysis of the Peach Bottom Unit 1 core is detailed. 19 references. (M.L.S.)

12012 (DOCKET-50-267(Amend.9)) ATTACHMENTS TO AMENDMENT NO. 9 TO APPLICATION FOR CONSTRUCTION PERMIT AND CLASS 104 LICENSE FOR THE FORT ST. VRAIN NUCLEAR GENERATING STATION. (Public Service Co. of Colorado, Denver). [nd]. 297p. Dep. CFSTI.

An index to AEC questions on Fort St. Vrain Power Reactor is presented in tabular form. Also given is information on: operation at power levels greater than 837 MW(t), probable error ranges for temperature coefficient, maximum error ranges in maximum excess and minimum shutdown reactivities, time constants for heat transfer from uranium-thorium to thorium fuel particles, extent of violation of rod sequencing patterns to exceed a worth of 0.015 ΔK, calculations to extend experimental results to fission product release, potential effects of sudden depressurization on plated out fission products, construction techniques and procedures for the concrete and prestressing system, corrosion protection of reinforcing steel and the prestressing system, combinations of loadings considered in the PCRV design, failure in the power range instrumentation initiating accident and causing loss of redundancy, potential for the simultaneous withdrawal of more than one control rod pair, consequences of reactor mode or interlock sequence switch being in wrong position, consequences of failures in the control systems which are relied upon to function after PSAR-postulated accident, consequences of permanent loss of forced helium circulation, consequences of sudden failure of penetration, radiological consequences of the maximum hypothetical accident if plateout activities were released with the primary coolant, changes necessary if tendon ducts were filled with grease, potential consequences of core heat-up accident with PCRV liner failure, determination of number of failed tendons, detailed acceptance standards or criteria for proof testing of PCRV, long-term consequences and procedures for recovering from core heat-up accident, independent audit of critical stages of construction and testing, possibility of PCRV liner failing during coolant loss accident, possibility of a crack causing rapid depressurization and not reclosing, SiC fuel particle coatings, releasable activity due to sudden depressurization, consequences of activity released during sudden depressurization, consequences of accidents, activity inventory, engineered safeguards, and normal operating temperatures. (M.L.S.)

12013 (DOCKET-50-286(Vol.1)) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. PRELIMINARY SAFETY ANALYSIS REPORT, DESCRIPTION OF SITE AND ENVIRONMENT, Exhibit B, Volume 1. (Consolidated Edison Co. of New York, Inc., New York). [nd]. 150p. Dep. CFSTI.

A detailed description of the site and environment for Indian Point Power Reactor, Unit 3, is given. Detailed information on location, topography, population and law usage, hydrology, meteorology, geology, seismology, and environmental radioactivity are presented. (M.L.S.)

12014 (DOCKET-50-286(Vol.2)(Pt.A)) [INDIAN POINT NUCLEAR GENERATING UNIT NO. 3 PRELIMINARY SAFETY ANALYSIS REPORT]. (Consolidated Edison Co. of New York, Inc., New York). [nd]. 175p. Dep. CFSTI.

The summary description of Indian Point Power Reactor, Unit 3, is given. Material is also included under the following broad topics: Reactor-design, nuclear design and evaluation, thermal and hydraulic design and evaluation, and mechanical design and evaluation; Reactor Coolant System-design and fabrication techniques, operation, components, and in-service inspection; Containment System-design and inspection and testing of containment structure; and Engineered Safeguards-safety injection system, containment spray, containment ventilation, containment isolation, isolation valve seal water system, and containment penetration and weld channel pressurization system. (M.L.S.)

12015 (DOCKET-50-286(Vol.2)(Pt.B)) [INDIAN POINT NUCLEAR GENERATING UNIT NO. 3 PRELIMINARY SAFETY ANALYSIS REPORT]. (Consolidated Edison Co. of New York, Inc., New York). [nd]. 190p. Dep. CFSTI.

Material on Indian Point Power Reactor, Unit 3, is presented under the following broad topics: Plant Instrumentation and Control-protective systems, control and regulating systems, nuclear instrumentation, non-nuclear process instrumentation, in-core instrumentation, operating control, and containment instrumentation; Electrical System-network interconnections, station distribution, and emergency power sources; Auxiliary and Emergency Systems-chemical and volume control system, auxiliary coolant system, sampling system, fuel handling system, and service water system; Steam and Power Conversion System-system design and operation and turbine controls; Radioactive Wastes and Radiation Protection; Safety Evaluation-core and coolant boundary protection analysis including plant abnormalities and transients, rod cluster control assembly withdrawal, rod cluster control assembly drop, chemical and volume control system malfunction, loss of reactor coolant flow, startup of an inactive coolant loop, loss of external electrical load, turbine trips due to steam and power system malfunction, loss of all ac power to station auxiliaries, turbine-generator unit overspeed, standby safeguards analysis, fuel handling accidents, accidental release of waste liquids and gases, rupture of steam generator tubes and steam pipes, ejection of rod cluster control assembly, loss of coolant accident evaluations, and environmental consequences of loss of coolant; and Seismic Design Criteria. (M.L.S.)

12016 (DOCKET-50-315 and 316) APPLICATION FOR CONSTRUCTION PERMIT AND OPERATING LICENSE FOR THE DONALD C. COOK NUCLEAR PLANT. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). [1967]. 85p. Dep. CFSTI.

Application for a construction permit and operating license for the Donald C. Cook Nuclear Power Plant is given. Included are financial data on American Electric Power (AEP), of which the owner, Indiana and Michigan Electric Company, is a subsidiary. The organizational structure of AEP is presented; estimated construction costs and proposed financing methods are delineated. (M.L.S.)

12017 (DOCKET-50-315 and 316(Vol.1)) DONALD C. COOK NUCLEAR PLANT PRELIMINARY SAFETY ANALYSIS REPORT. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). [1967]. 525p. Dep. CFSTI.

Material is presented under the following broad headings: Summary Description; Site and Environment, including site description, meteorology, mathematical models for vent and stack accidental releases, geology, hydrology, seismology, limnology and ecology, and environmental radiation monitoring; Reactor, including principle design criteria and design; Reactor Coolant System, including design bases, systems design and operation, safety limits and conditions, and tests and inspections; Containment System, including general design criteria, containment structure, containment system design, stress analysis, penetrations, ice condenser, containment isolation system, containment ventilation system, and leak testing. (M.L.S.)

12018 (DOCKET-50-315 and 316(Vol.2)) DONALD C. COOK NUCLEAR PLANT PRELIMINARY SAFETY ANALYSIS REPORT. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). [1967]. 437p. Dep. CFSTI.

Material is presented under the following broad topics: Engineered Safeguards, including criteria, emergency core cooling, and containment spray system; Plant Instrumentation and Control, including general design criteria, plant protective systems, regulating systems, nuclear instrumentation, process and containment instrumentation, in-core instrumentation, operating controls stations, operating conditions, and tests and inspections; Electrical Systems, including design bases, network interconnections, station service systems, emergency power system, and design evaluation; Auxiliary and Emergency Systems, including general design criteria, chemical and volume control system, system design and operation, residual heat removed system, spent fuel pit cooling system, component cooling system, sampling system, fuel handling system, and facility service system; Steam and Power Conversion System, including design bases, main steam system, turbine generator, main condensers, condensate and feedwater systems for, and design evaluation; Waste Disposal and Radiation Protection Systems, including waste disposal system, and radiation protection. (M.L.S.)

12019 (DOCKET-50-315 and 316(Vol.3)) DONALD C. COOK NUCLEAR PLANT PRELIMINARY SAFETY ANALYSIS REPORT. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). [1967]. 301p. Dep. CFSTI.

Material is included under the following broad topics: Initial Tests and Operation, including pre-critical testing and operation, initial core loading, and zero power testing; and Safety Analysis, including core and coolant boundary protection, standby safeguards analysis, and rupture of a reactor coolant pipe. Appendices include environmental studies reports from Dames and Moore, design criteria for structures and equipment, a functional evaluation of the components of systems that are shared by the two units, and determination of reactor pressure vessel NDTT. (M.L.S.)

12020 (DRP/ML/CA-Nd-1011) ETUDES DE REACTEUR RAPIDE REFROIDI PAR SODIUM. DISPOSITION DES CIRCUITS PRIMAIRES AUTOUR DE LA CUVE AVEC ECHANGEURS INCORPORES. (Studies of Fast Reactor Cooling by Sodium. Arrangement of Primary Circuits About the Tank Along With Incorporated Exchangers). Gollion, H. J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 8, 1965. 8p. (In French). Dep. CFSTI.

An arrangement of the primary circuits around a sodium-cooled reactor is investigated. The principal characteristic of the arrangement is the incorporation into the reactor vessel of the primary heat exchangers arranged around the neutron shield. This arrangement makes it possible to integrate into the interior of a single vessel all the static elements of the primary circuit. The principal advantages of this arrangement are the decrease of the mass of the radioactive primary circuit, the decrease of the charge losses, the elimination of the risk of draining of the primary circuit, and the ease of installation of the ensemble. The inconveniences are the increase of the cost of the vessel, of the neutron shielding, and, too a lesser extent, of the heat exchangers. (tr-auth)

12021 (EUR-3639f) INCIDENCE DES REGIMES FISCAUX EN VIGUEUR DANS LES PAYS DE LA COMMUNAUTE SUR L'ECONOMIE DES CENTRALES NUCLEAIRES. 1ERE PARTIE. LES REGIMES FISCAUX DES DIFFERENTS PAYS. 2EME PARTIE. STRUCTURE DU SECTEUR DE LA PRODUCTION D'ENERGIE ELECTRIQUE DANS LES PAYS DE LA CEE. 3EME PARTIE. EVALUATION DE LA PROPORTION DES TAXES DANS LE COUT D'INVESTISSEMENT ET DANS LE PRIX DE REVIENT DU kWh, POUR DES CENTRALES NUCLEAIRES ET CLASSIQUES DE 500 MWe. (The Effect of Fiscal Systems in the Community Countries on Nuclear Power Plant Economics. Part 1. Fiscal systems in the Various Countries. Part 2. Structure of the Electrical Energy Producing Sector in the Community Countries. Part 3. Estimate of the Proportion of Taxes in Capital and Generating Costs per kWh for 500 MWe Nuclear and Conventional Power Stations). (Metra International, Paris (France)). Dec. 14, 1967. Contract 028-66-2 ECIF. 503p. (In French).

The different fiscal factors affecting the generating costs of nuclear power are compared with conventional power cost in the different countries of the CEEA. The study consists of the four following phases: a general study that defines the fiscal systems and the state of the laws on which they are based; a particular study emphasizing the direct and indirect money policies concerning investment and generating costs, in comparison to conventional power costs; requirements for repaying fiscal charges of tax for goods consumed according to the common statutes, taking into account Amendment III of the instituting treaty of the CEEA; a part which contains the practical uses which illustrate the monetary requirements for the member countries; a final analysis which emphasizes the conditions placed on the investments made in the area of electrical power plants, principally nuclear, and the problem areas affecting the generating cost of nuclear power because of the heterogeneity of the fiscal policies involved. (M.L.S.)

12022 (EURFNR-415) REACTOR TEMPERATURE TRANSIENTS WITH SPATIAL VARIABLES. SECOND PART. AXIAL ANALYSIS. Caldarola, L.; Niedermeyr, W.; Woit, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). July 1967. 134p. (KFK-618; EUR-2403). Dep.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The space-time dependent coolant heat balance equation is solved by the Laplace transform method to obtain coolant temperature transients. The lumped parameter model is used; this does not take into account heat propagation inside the fuel or heat transport along the coolant channel. Numerical examples are given. The mathematical bases of the equations used are derived. (M.L.S.)

12023 (GA-8153) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending July 31, 1967. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 30, 1967. Contract AT(04-3)-314. 60p. Dep. CFSTI.

PEACH BOTTOM POWER REACTOR, UNIT 1—testing of, approach-to-power; power history for May-July 1967; power calibration tests in; control of, effects of variation of demand load on; performance of, dynamic analysis during approach-to-power of; core for, verification of heat transfer coefficient for; helium coolant for, purification system for

BOILERS—performance of Peach Bottom Power Reactor, Unit 1 helium-side

REACTIVITY—temperature coefficient measurements in Peach Bottom Power Reactor, Unit 1

XENON—measurements in Peach Bottom Power Reactor, Unit 1

SHIELDING—efficiency of Peach Bottom Power Reactor, Unit 1, full power measurements of

HELIUM—purification system for Peach Bottom Reactor, Unit 1 coolant

REACTOR FUEL ELEMENTS—fission product release from Peach Bottom Power Reactor, Unit 1 (M.L.S.)

12024 (GAMD-6754) GAZELLE V: A CODE FOR THE THERMAL DESIGN OF HOMOGENEOUS GAS-COOLED REACTORS (PARTICULARLY FOR FAST REACTORS). Fortescue, Peter (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 1, 1965. Contract AT(04-3)-167. 39p. Dep. CFSTI.

A computer code, GAZELLE-V, for calculating the influence of prescribed limitations and objectives on the design of fast gas-cooled reactor core is described. The input consists of limitations such as pumping power fraction, working pressure, nature of coolant, overall core size and shape, and inlet, outlet, and maximum surface temperatures. Output consists of: complete core and fuel element specifications such as performance data, power density, maximum and mean fuel temperatures, and temperature distributions. Sample input instructions are shown. Total output quantities are listed and defined, where necessary. Theoretical bases for the code are developed; nomenclature is defined. (M.L.S.)

12025 (HPR-78) EXPERIMENTAL BURN-OUT AND HYDRAULIC INSTABILITY INVESTIGATIONS. Rolstad, E.; Kjaerheim, G.; Svanholm, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Oct. 1967. 91p. Dep.

Burn-out and instability experiments have been performed in-pile on a 7-rod fuel cluster. Burn-out experiments were made at two system pressures and over a wide range of channel powers. The channel stability was studied at two system pressures and at different degrees of inlet throttling. The results generally agreed with the expected behavior. (auth)

12026 (HPR-87) EXPERIENCE AT HBWR WITH ACTIVITY RELEASE IN CONNECTION WITH FUEL FAILURES. Ottersen, Ulf (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Oct. 1967. 94p. Dep.

A description of the Halden Boiling Reactor is given; siting and meteorological aspects are discussed. A description of the fuel used for testing is given; an exposure history is presented in tabular form. Failure histories are shown in chart form. Activity control methods are discussed. Irradiated fuel handling methods are described. Fission product inventory and release are detailed. Derived working limits are delineated; limits for various sections of the reactor facility are presented and discussed. Released activities and their meteorological aspects are considered. Measurements of activities in the reactor facility areas are listed and discussed. Reactor down time due to fuel failures is tabulated. (M.L.S.)

12027 (HPR-88) HBWR QUARTERLY PROGRESS REPORT, JULY TO SEPTEMBER 1967. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Nov. 1967. 78p. Dep.

HALDEN BOILING REACTOR — moderator for, determination of concentration of heavy water; incidents involving heavy water losses at; control rods for, effects of temperature on travel time of; physics measurements in, low powder; hydrodynamics testing for, comparison of in-pile and out-of-pile; control of, use of in-line computer for
REACTOR CONTROL ELEMENTS — travel time of Halden, effects of temperature on
COMPUTERS — control of Halden Boiling Reactor using in-line
REACTOR FUELS — testing of, Halden program for in-pile
REACTOR FUEL ELEMENTS — valves for Halden instrumented, description of pneumatic throttle
TRANSDUCERS — development of dynamic fission gas pressure (M.L.S.)

12028 (KR-121) MODEL FOR THE DYNAMICS OF NUCLEAR REACTORS WITH BOILING COOLANT WITH A NEW APPROACH TO THE VAPOUR GENERATING PROCESS. Bakstad, P.; Solberg, K. O. (Institutt for Atomenergi, Kjeller (Norway)). Aug. 1967. 79p. Dep.

A dynamic model is described which can be used for steady state, stability and transient analysis of boiling channels and nuclear reactors with a boiling coolant. Based upon a certain physical model for the vapor generating process, wherein the lack of thermal equilibrium between the vapor and fluid phases is a fundamental assumption, a general description of the hydraulics is derived. This description permits the direct determination of the vapor content in the various parts of the hydraulic loop: in the subcooled and bulk boiling regions, in the riser and downcomer parts. No explicit calculations of boiling boundaries from empirical relationships are necessary. Fluid flashing and vapor condensation, due to pressure changing with time, are inherently taken care of. Further vapor carry-under in the downcomer and reversal of the flow in some part of the loop can easily be accounted for. Some comparisons with experimental loop results are shown, for steady state conditions and for the hydraulic stability limits. Further examples of applications of the model to reactor dynamics analysis are given, which demonstrate the importance of thermal "non-equilibrium." The model, which represents a new approach rather than a final result, points out that basic problems in two-phase dynamics are still to be solved. (auth)

12029 (LA-3835) QUARTERLY STATUS REPORT ON ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FOR PERIOD ENDING OCTOBER 31, 1967. (Los Alamos Scientific Lab., N. Mex.). Dec. 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Power profiles of the UHTREX core mockup are shown, graphically, as a function of position. Preliminary values for relative reactivity worths of U and (U-Th) fuels are given. Rod drop measurements for determination of neutron lifetime are described. Critical mass determinations are given; effects of perturbations on k_{eff} are tabulated as a function of perturbation. (M.L.S.)

12030 (NAA-SR-6492) REMOVAL OF A MAIN HEAT TRANSFER SYSTEM THROTTLE VALVE AT THE HALLAM NUCLEAR POWER FACILITY. Kopchinski, N. L. (Atomics International, Canoga Park, Calif.). May 25, 1963. Contract AT(11-1)-Gen-8. 17p. Dep. CFSTI.

The actual work process involved in removal and repair of a primary loop throttle valve is described. The project was necessitated by the malfunctioning of the throttle valve in primary sodium loop No. 3. A repair of this magnitude was not covered in the manufacturer's specifications. It thus became necessary to establish a tentative work procedure before commencing the repair, and to improvise some procedural steps as the work progressed. This account of the work is designed to provide a reference in the event it should become necessary to repeat a project of this nature. (auth)

12031 (NAA-SR-Memo-12401) PIQUA FUEL ELEMENT EROSION ANALYSIS. Toews, R. E. (Atomics International, Canoga Park, Calif.). Mar. 31, 1967. 11p. Dep. CFSTI.

The mechanism of fluid erosion and particulate erosion were evaluated; based on available data, it was concluded that the velocities in the Piqua fuel element would not create any erosion problems in the modified design. (auth)

12032 (NAA-SR-Memo-12472) NUCLEAR SAFETY SRE CORE III FUEL ELEMENT STORAGE. Ketzlach, Norman (Atomics International, Canoga Park, Calif.). May 17, 1967. 7p. Dep. CFSTI.

The nuclear safety of a single-plane array of SRE Core III fuel elements, spaced on 12-inch centers, has been evaluated. The array is less than 45% of critical, based on the mass/unit area principle for the fuel rod sizes of interest. This is independent of the degree of water flooding. A fully-flooded array of the assembly of elements spaced as stated above would have a k_{eff} of less than 0.6. An unmoderated assembly of fuel of the given enrichment having a neutron-reflection equivalent to water would require at least three times as much fuel for criticality, independent of spacing between elements or the thickness of water reflector. (auth)

12033 (NAA-SR-Memo-12536) PNPF SINGLE ELEMENT (IPT FLOW) HYDRAULIC TEST REPORT. Arnold, J. E. (Atomics International, Canoga Park, Calif.). Aug. 8, 1967. 23p. Dep. CFSTI.

Data obtained from the test program on the modified IPT outlet are given; the acceptability of the hydraulics associated with this design is discussed. Detailed analysis of the data and an analytical evaluation of the design will be included in a report now in preparation. (auth)

12034 (NYO-3660-1) DESIGN CRITERIA FOR HIGH-PRESSURE, HIGH-TEMPERATURE BOLTING. State-of-the-Art Summary and Program Recommendations. Cooper, W. E.; Widmer, R.; Signorelli, J. A.; Brodrick, R. F. (Teledyne Materials Research Co., Waltham, Mass.). July 1967. Contract AT(30-1)-3660. 66p. Dep. CFSTI.

The next generation of power-producing nuclear reactors is expected to operate at higher temperatures than reactors now in operation or under construction. These conditions will require that bolted closures in the systems be designed to operate under conditions not presently covered by ASME Codes. It is, therefore, necessary that steps be taken to extend the Codes to meet these new conditions. Surveyed are: 1) the anticipated needs of the nuclear industry, 2) the availability of metallurgical data which would be required for codification to meet the anticipated needs, and 3) the status and availability of stress analysis and methods and design criteria to apply to the new conditions. It is found that closure temperatures up to 1300°F and pressures up to 4000 psi may be encountered. It is also found that, although creep data for bolting materials under consideration are available, stress-relaxation data (of particular importance here) are very meager. Further, methods for converting creep data to stress relaxation data are unreliable. A specific program for the collection of required data on prospective high-temperature bolting materials is recommended. These data would be used in the selection of specific materials and the ultimate codification for the anticipated reactor operating conditions. (auth)

12035 (ORNL-4191) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending August 31, 1967. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 260p. Dep. CFSTI.

MOLTEN SALT REACTOR EXPERIMENT — operations and performance during January to August 1967
REMOTE-HANDLING EQUIPMENT — experimental facilities sampler-enricher, description of MSRE
GAMMA RADIATION — spectra MSRE heat exchanger, measurement of
HEAT EXCHANGERS (LIQUID-LIQUID) — radiation monitoring of MSRE, gamma

MOLTEN SALT REACTOR EXPERIMENT — neutron spectra measurements in
URANIUM-233 — fuel performance in MSRE of, power level measurements with oscillation periods for
MOLTEN SALT BREEDER REACTOR — design of, conceptual; physics measurements for, optimized design
MOLTEN SALT REACTOR EXPERIMENT — fuel salt analysis of
MOLTEN SALT REACTOR EXPERIMENT — fission products in, analysis of
FISSION PRODUCTS — deposition in MSRE of, analysis of
LITHIUM FLUORIDES — BeF_2–LiF, precipitation of protactinium and uranium in MSRE by melts of
BERYLLIUM FLUORIDES — BeF_2–LiF, precipitation of protactinium and uranium in MSRE by melts of
MOLYBDENUM FLUORIDES — reactions in MSRE of, analysis of chemical
PROTACTINIUM-233 — separation from molten fluorides in MSRE of, method for
SODIUM FLUOROBORATES — $NaBF_4$–NaF, dissociation vapor pressures in MSRE, phase diagram of
SODIUM FLUORIDES — $NaBF_4$–NaF, dissociation vapor pressures in MSRE, phase diagram of
REACTOR FUELS — oxide measurements in MSRE salts; uranium measurements in MSRE fused salt, trivalent
ORNL RESEARCH REACTOR — experimental facilities for fused-salt convection loop in, description of
GRAPHITE — radiation effects in MSRE convection test loop in ORR
HASTELLOY N — radiation effects in MSRE at 1200°F on, neutron
NEUTRONS — effects on physical properties of Hastelloy N at 1200°F in MSRE
GRAPHITE — testing physical properties for MSBR,
REACTOR EXPERIMENTAL FACILITIES — fused-salt convection loop for ORR, description of (D.C.C.)

12036 (WAPD-TM-637) DEPLETION ANALYSIS OF SHIPPINGPORT (PWR) CORE-1, SEEDS 1 AND 2, USING THE TNTO2 COMPUTER PROGRAM. Stuart, M. R.; Sphar, C. D. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Nov. 1967. Contract AT-11-1-GEN-14. 68p. Dep. CFSTI.

An analysis of the lifetime behavior of Shippingport (PWR) Core 1, Seeds 1 and 2, has been completed utilizing the flux synthesis technique as embodied in the digital computer program TNT02. The overall objective of this study was to assess the ability of present design techniques to describe the lifetime behavior of the Core 1 type of light water moderated, seed-blanket reactor. Comparisons are made for long term reactivity behavior, gross power distribution and isotopic materials changes for blanket fuel rods. The results of this study indicate a distinct improvement in reactivity variation with lifetime, the total variations being about 1½ percent ΔK for two seed lifetimes, as compared to earlier studies which gave a 2½ percent ΔK variation. Gross power distribution and materials inventory estimates were also improved as a result of the greater geometric detail used in the present study. (17 references). (auth)

12037 RECENT ADVANCES IN THE TECHNIQUES OF IRRADIATION EXPERIMENTS ON REACTOR MATERIALS AT HIGH TEMPERATURES AND HIGH RATINGS. Atkinson, J. R. (United Kingdom Atomic Energy Authority, Dounreay, Eng.). pp 227-45 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Improvements in irradiation facility experiments include: ceramic fuels for fast reactors with capsule concept of Na and Cu containers to prevent varying temperatures and flux depression; electric heating to maintain fixed temperature with nucleate boiling heat transfer; ring configurations to maintain accuracy in very small gas gaps; fuel capsules fabrication for operation at 1000° to 1200°C; and use of silicon carbide for gas gap conduction replacement at high temperatures. (D.C.C.)

12038 WATER-COOLED REACTORS. Haslam, R. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). Electron. Power, 13: 370-3(Oct. 1967).

More water-cooled reactors are being built than any other type in the world to-day. They include boiling water and pressurized water systems, moderated and cooled by ordinary water, and the Canadian CANDU reactor, in which heavy water is used as moderator and coolant. Now being commissioned, the British steam-generating heavy-water reactor combines features from many earlier types, and is expected to prove of worldwide interest. (auth)

12039 THE 660 MW NUCLEAR POWER STATION STADE WITH SIEMENS PWR. Frewer, H.; (Technische Stammabteilung Energieversorgung, Erlangen, Ger.); Keller, W. Atomwirt., Atomtech., 12: 568-73(Dec. 1967). (In German).

A description of the Stade Power Reactor is given. The 660 MW pressurized water reactor will be built by Siemens. Design parameters are listed. A layout of the power station is shown; cross sectional views of the reactor building are given. A typical fuel element is shown; the pressure vessel is shown in cross section. Reactor protection systems are discussed briefly; auxiliary and steam conversion systems are outlined. (M.L.S.)

12040 FAST REACTORS. Campbell, R. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). Electron. Power, 13: 373-6(Oct. 1967).

The bulk of nuclear power finally must come from fast-breeder reactors, with thermal reactors providing the stockpile of Pu for initial fueling, until the breeding gain in the fast reactors matches the rate of increase of generating capacity. (auth)

12041 EFFICIENCY OF ROTATING REGULATORS PLACED IN A RADIAL REACTOR REFLECTOR. Barkov, S. N. At. Energ. (USSR), 23: 351-2(Oct. 1967). (In Russian).

Rotating disks in a radial reflector can be used to control small-sized power reactors. A method of calculating the compensating ability of a set of regulating disks is presented. A method of statistical tests for calculating the effective reflecting properties of the reflector (of the effective albedo) with the regulators and without them, and an analytical method of calculating the reactor parameters under albedo limiting conditions form the bases of the approach. An accuracy of 10 to 15% of Δk_{eff} is attained on following 1000 to 2000 events for each neutron group. The effect of the regualtors on the change in reactor spectrum is automatically taken into account in solving the diffusion equation for the active zone of the reactor. Calculations showed that effects up to 0.1% of the reactivity could be followed by the use of correlation calculation by the albedo method. (TTT)

12042 DERIVATION OF DYNAMIC EQUATIONS OF FLOWING FUEL REACTOR. Goryachenko, V. D.; Sabaev, E. F. At. Energ. (USSR), 23: 295-300(Oct. 1967). (In Russian).

Simplified equations of the dynamics of reactors with circulating fuel were derived. The derivation of the equations was based on the smallness of the contribution of the delayed neutrons to the multiplication factor. An example was given of the applicability of the equations obtained, illustrating the characteristics of reactors with circulating fuel. (tr-auth)

12043 TRIUMPHANT ADVANCE OF NUCLEAR POWER STATIONS. Finke, W. Atomwirt., Atomtech., 12: 565-7 (Dec. 1967). (In German).

The foundations of nuclear power plants are discussed in respect to their twenty-fifth year. Milestones of nuclear energy are listed. Future electricity needs of the German Federal Republic are considered; the role of nuclear energy in filling these needs is discussed. Problems related to this role are outlined. (M.L.S.)

12044 25 YEARS OF REACTOR SAFETY. Mialki, W. (Technische Univ., Berlin). Atomwirt., Atomtech., 12: 573-7(Dec. 1967). (In German).

Questions of reactor safety are presented with reference to the twenty-five year history of the nuclear industry. A complete safety history is tabulated, showing number of personnel involved, deaths, radiation dose, date, reactor/location, and remarks. A safety evaluation is presented from a personnel injury point of view; comparisons of unplanned failures in nuclear power plants are shown, graphically, for the period from 1958 to 1966. 9 references. (M.L.S.)

12045 BOILING WATER REACTOR WITH TWISTED TAPES BETWEEN THE FUEL RODS. Vollradt, J. (AEG-Kernenergie-Versuchsanlage, Grosswelzheim, Ger.). Atomwirt., Atomtech., 12: 595-601(Dec. 1967). (In German).

Efforts toward reduction of power generating costs for boiling water reactors are discussed. Use of twisted tapes inside the fuel elements to increase the power density ratings is described. Thermal and hydraulic experiments using the twisted-tape elements are outlined; results are presented. Design data for boiling water reactor twisted-tape elements are given. (M.L.S.)

12046 A STUDY CONCERNING THE NUMBER OF EFFECTIVE EQUALLY LIMITING HOT CHANNELS IN A REACTOR WITH A COSINE POWER DISTRIBUTION. Judge, F. D. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng., 31: 147-69(1968).

Thermal design calculations accounting for the power decrement in more than one reactor channel are considered. Failure probability is then related to this power decrement. (M.L.S.)

12047 PROTOTYPE DRAGON REACTOR UNNECESSARY. Elec. Rev., 181: 161(Aug. 4, 1967).

Operational experience gained with the 20-Mw (thermal) Dragon high temperature gas-cooled reactor (HTR) at Winfrith, Dorset (England) has led to the suggestion that a large commercial HTR power station could be built without the need for a prototype or demonstration plant. Economic estimates for plant developments are presented. (TSS) (BBB)

12048 PUBLIC REACTIONS TO NUCLEAR FACILITIES. Grendon, Alexander (Univ. of California, Berkeley). Amer. J. Public Health, 57: 1263-8(Aug. 1967).

Some aspects of public opinion concerning nuclear facilities, constructed or planned, in the United States are examined, and it is proposed that the public should be informed of the favorable public health features of nuclear as opposed to fossil-fuel power plants. (TSS) (BBB)

12049 NUCLEAR POWER: A BASIC BRIEFING. Cope, David F. (Atomic Energy Commission, Oak Ridge, Tenn.). Mech. Eng., 89: 48-53(June 1967).

Recent developments in technology and economics of nuclear reactors used for electric power generation are reviewed. The reactors currently being used are water-cooled and water-moderated, the 2 dominant types being the boiling water reactor (BWR) and the pressurized water reactor (PWR). The breeder reaction is explained and its significance to the future of nuclear power generation is mentioned. (TSS) (BBB)

12050 LIMITLESS ENERGY AHEAD. Avila, Charles F. EEI (Edison Elec. Inst.) Bull., 35: 308-10(Oct. 1967).

Advances in electric power development are briefly reviewed and estimates of increases of capacity to the year 2000 projected, with attention to the role of nuclear energy. The concept of negative nuclear fuel consumption is explained. (TSS) (BBB)

12051 EVOLUTION AND HAZARDS OF ENERGY PROBLEMS. Ailleret, Pierre (Electricte de France, Paris). Rev. Gen. Elec., 76: 869-74(June 1967). (In French).

Electricity is studied in its evolution as part of the consumption of energy in France. The evaluation of an energy balance will require study of 2 completely separate balances: one for electricity based on U and hydropower, and the other on fossil fuels. A space constant is developed in connection with the economics of electricity transport to evaluate the efficiency of interconnection of electric networks. The next step in increasing carrier voltage is discussed. (TSS)

12052 STAFFING NUCLEAR PLANTS. Jones, Charles F. (NUS Corp., Washington, D. C.). Power Eng., 72: 47-9; 80(Jan. 1968).

The conclusion to a two-part article analyzes the company support personnel needed behind the plant organization. To man nuclear plants now on order, an average addition of 30 trained operating and support people is needed every month for six years. Reactor training will be a real bottleneck. (auth)

12053 REACTOR CORE THERMAL PERFORMANCE. Dean, R. A. (Westinghouse Electric Corp., Pittsburgh). Power Eng., 72: 44-6(Jan. 1968).

A key factor in the performance of a nuclear power reactor is the thermal design of the core. A basic description of the principles involved and an explanation of how the performance has been steadily improved are presented. (auth)

12054 NUCLEAR SAFETY. Volume 9, Number 1. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). Contract W-7405-eng-26. One of the Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Jan.-Feb. 1968. 106p. GPO $1.00 Domestic, $1.20 Foreign.

Separate abstracts are prepared for the 15 separate sections concerned with nuclear safety. Summary material is presented under the following broad subjects: General Safety Criteria; Accident Analysis; Control and Instrumentation; Plant Safety Features; Consequences of Activity Release; Operating Experiences; and Current Events summary which includes a tabular listing of reactors undergoing regulatory action. (M.L.S.)

For abstracts of individual sections see: 10493, 10533, 10750, 12055–12065, and 12148.

12055 SITING OF POWER REACTORS. Price, Harold L. Nucl. Safety, 9: 1-4(Jan.-Feb. 1968).

AEC regulations regarding reactor siting and the AEC position on the subject, at this time, are discussed. Factors affecting reactor siting are detailed in Part 100 of the Code of Federal Regulations, Title 10. They include characteristics of reactor design, population density, and physical conditions of the site. Even where unfavorable site characteristics exist, however, the site may be judged acceptable if adequate compensating engineered safeguards are included in the design. There are two major areas related to power-reactor siting that have proved to be the most troublesome: metropolitan siting and the location of reactors in areas of high seismicity. The following are providing help in resolving the safety questions involved: Codes and specifications are being improved, more reliable engineered safety features are being designed, research and development work is under way, experience in the operation of power reactors is being gained, and the development of more definitive criteria is planned or being considered. Meanwhile, it is not likely that a large power reactor will be located in the midst of a densely populated metropolitan area or on a major active fault such as the San Andreas. (auth)

12056 SAFETY IN HIGH-TEMPERATURE GAS-COOLED REACTORS. Kaplan, S. I. Nucl. Safety, 9: 4-9(Jan.-Feb. 1968).

High-temperature gas-cooled reactors have certain safety advantages over liquid-cooled reactors, including substantial freedom from reactivity effects due to coolant voids and moderator density changes. Certain unique aspects requiring consideration include neutron spectral shifts due to moderator temperature changes, reactions between graphite and coolant contaminants, fission-product behavior, and the use of prestressed-concrete pressure vessels. A brief history of the conceptual evolution and a description of a typical HTGR are included, and the extent, direction, and needs of the continuing research program for this concept are reviewed. 31 references. (auth)

12057 CORE MELT-THROUGH AS A CONSEQUENCE OF FAILURE OF EMERGENCY CORE COOLING. Fontana, M. H. Nucl. Safety, 9: 14-24(Jan.-Feb. 1968).

A condensed compilation of some of the technical findings of a task force commissioned to investigate the possibility and consequences of the core melting through the pressure vessel and the containment vessel in the event of loss of emergency core cooling are discussed. A reasonable sequence of events during the hypothetical accident is described, and times required for initiation and completion of each event are estimated. The subsequent handling of the molten masses is then considered. A qualitative description of fission-product behavior is given; the possibilities and effects of steam explosions are discussed. The conclusions of the task force are then presented, along with additional observations by the compiler. 21 references. (auth)

12058 DIGITAL COMPUTERS AS PROCESS INSTRUMENTATION. Whitt, R. E.; Duggins, B. C. Nucl. Safety, 9: 25-8 (Jan.-Feb. 1968).

There has been increasing interest in the application of digital computers to operation of nuclear power plants. The digital system becomes attractive economically as plants become larger and more complex. Following a review of a recent study that considered satisfying power plant instrumentation requirements through the use of special-purpose digital systems, it is suggested that, prior to making any strong commitment to the use of digital computers, it is advisable to consider the proven merits of conventional analog methods. 12 references. (auth)

12059 PRINCIPLES OF DESIGN OF REACTOR-PROTECTION INSTRUMENT SYSTEMS. Hanauer, S. H.; Walker, C. S. Nucl. Safety, 9: 28-34(Jan.-Feb. 1968).

Definitions of protection systems include references to functions whose failure when needed would have serious results. Design of an adequate system requires consideration of the performance required under accident conditions, as well as the reliability of the devices involved. Performance is related to the capability of the system to cope with an accident; reliability is associated with component failures. Factors important to reliability are redundancy, coincidence, testing, and maintenance. Interdependence between the protection system and the instrument system that normally operates the plant can seriously affect safety. The role of the human operator in plant protection is strongly dependent on design of the protection system. (auth)

12060 METHYL IODIDE BEHAVIOR IN SYSTEMS CONTAINING AIRBORNE RADIOIODINE. Mishima, J. Nucl. Safety, 9: 35-42(Jan.-Feb. 1968).

Methyl iodide is the fraction of airborne radioiodine most difficult to retain on traps considered for nuclear reactors. In assessing the consequences of postulated reactor accidents, investigators have shown that such a fraction can have a serious impact. The scientific literature describing research and other data concerned with the formation, behavior, and removal of gaseous methyl iodide in a reactor containment system following a fuel-meltdown accident is reviewed. 104 references. (auth)

12061 SECONDARY REASONS FOR INCORPORATING NUCLEAR SAFETY IN NUCLEAR ENGINEERING CURRICULA. SOCIAL PERSPECTIVE AND NUCLEAR SAFETY EDUCATION. Hetrick, David L. Nucl. Safety, 9: 59-61(Jan.-Feb. 1968).

Nuclear Safety Engineering education is discussed from the aspect of nuclear-engineer-role-in-society. Various misunderstandings which have been propagated by the uninformed are discussed; the role of the nuclear engineer in alleviating misunderstandings is presented. 9 references. (M.L.S.)

12062 SECONDARY REASONS FOR INCORPORATING NUCLEAR SAFETY IN NUCLEAR ENGINEERING CURRICULA. THE SYSTEMS ENGINEERING APPROACH AND NUCLEAR SAFETY EDUCATION. Jankowski, F. J. Nucl. Safety, 9: 61-4(Jan.-Feb. 1968).

Use of an integrated approach to Nuclear Safety Engineering education is discussed. Methods of approach to such a systems engineering concept are outlined. (M.L.S.)

12063 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Whetsel, H. B.; Savolainen, A. W. Nucl. Safety, 9: 74-87(Jan.-Feb. 1968).

Studies on the following broad topics are outlined: Water Reactor Safety including reactor kinetics and related studies, power burst facility, and space dependent kinetics; Integrity of Primary Systems including studies of rupture and cracking in water reactor primary piping, fatigue tests of vessels and effect of weld defects, investigation of nonradial nozzle connections in spherical shells, test of PM-2A reactor vessel, investigations of ductile pipe rupture, continuous crack monitor, stresses in closely spaced openings, and variability of impact data on reactor vessel steels; Loss of Coolant and Containment Response including in-core emergency cooling studies, and chemical reactions (metal-water reactions); Fission Product Behavior under Accident Conditions including behavior of fission products on the in-pile destruction of reactor fuels; Nuclear Safety Pilot Plant, fundamental studies of fission product iodine and their application to the development of relative coatings, characterization of accidents and release technology, removal of gasborne fission products by liquids, prompt fission product release; Multipurpose Projects including Containment Systems Experiment and an evaluation of the applicability of existing data to the analytical description of a nuclear reactor accident; Safety Test Experiment Program including Loss of Fluid Test (LOFT), LOFT support activities, LOFT stresses under blowdown conditions, fission product release at LOFT conditions, fission product release as a function of burnup, testing of LOFT fission product sampling capsules, developing instrumentation to measure the chemical state of iodine and particle size of mixed fission products, and controlled environment release tests; In-Plant Testing including in-plant testing and reliability monitoring program. (M.L.S.)

12064 AEC ADMINISTRATIVE ACTIVITIES. Blakely, J. P. Nucl. Safety, 9: 88-91(Jan.-Feb. 1968).

Excerpts on the proposed amendment to 10 CFR Part 50, General Design Criteria are given, with references to each original comment. Comments quoted are those by: Black and Veach, Commonwealth Edison, Southern California Edison, General Electric, Nuclear Safety Information Center, Yankee Atomic Electric, Babcox and Wilcox, Reactor Instrumentation and Control Standards Subcommittee—Nuclear Science Group (IEEE), Los Alamos Scientific Laboratory, and Wisconsin Electric Power Company. A discussion of the pressure vessel design criteria is given. (M.L.S.)

12065 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. Nucl. Safety, 9: 91-9(Jan.-Feb. 1968).

AEC regulatory action is summarized for the following reactors: Bolsa Island 1 and 2 (Docket 50-307 and 50-308), Burlington (Docket 50-272), Crystal River 3 and 4 (Docket 50-202 and 50-203), Fermi (Docket 50-16), Kewannee (Docket 50-305), Midwest Fuel Recovery Plant (Docket 50-268), Oconee 1, 2 and 3 (Docket 50-269, 50-270, and 50-287), Prairie Island (Docket 50-306), Savannah (Docket 50-238), and Zion (Docket 50-304). Changes in Licensing and Regulations in 10 CFR are presented. These are Parts: 1, 10, 30, 31, 32, 50, 115. 25 references. (M.L.S.)

12066 PRESSURE-TUBE REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,415,640. Sept. 20, 1965. Filed Aug. 14, 1964.

A flexible connecting element is fixed between the outer shell and the base-plates of the reactor vessel by thin welds. At their extremities each pressure-tube is surrounded by a sleeve which is fixed to the base-plates also by thin welds. Such an arrangement allows the outer shell to freely expand independently of the pressure-tubes. (IIB)

12067 NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,415,683. Sept. 20, 1965. Filed Aug. 28, 1964.

A heat exchanger and a gas-cooled reactor are enclosed in a common concrete pressure vessel. This pressure vessel also comprises a tank containing the liquid moderator. Vertical calandria tubes traverse this tank and receive fuel elements. The extension of each calandria tube is connected to a tubular member secured to the pressure vessel. The tank is suspended to these calandria tubes. A change in diameter of the extension of each calandria tube prevents any direct leakage of neutrons escaping as a support for the biological shield plugs. (IIB)

12068 LIQUID-MODERATOR NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,415,684. Sept. 20, 1965. Filed Aug. 28, 1964.

Fuel elements are disposed in vertical calandria tubes which traverse a moderator tank. This tank and a heat exchanger are enclosed in a common concrete pressure vessel. Gas circulates inside the pressure vessel in heat exchange with the fuel elements and the heat exchanger. A pressure equalizing device is provided between the gas circuit and the moderator circuit and comprises a cylindrical vessel in which a movable piston separates two chambers respectively connected to the gas circuit and the moderator circuit. (IIB)

12069 COMBINATION FOSSIL FUEL AND SUPERHEATED STEAM NUCLEAR POWER PLANT. Vuia, R. E. (to Combustion Engineering-Superheater Ltd.). Canadian Patent 767,374. Sept. 19, 1967.

The saturated or low pressure steam generated by a nuclear reactor is superheated in a fossil-fuel steam generator. This steam is then conveyed from the superheater to a turbine operating on the superheated steam cycle. This superheater is located within the fossil-fuel steam generator remote from the burner zone, with the steam generating tubes surrounding this burner zone. Either one of these steam generators may be operated independently of the other. When the nuclear reactor is operating with the fossil-fuel steam generator out of service, saturated steam is supplied to the turbine. Provision is made to bypass the high pressure turbine at this time thus avoiding excess moisture on the blades. (F.S.A.)

12070 NUCLEAR REACTOR FUEL ELEMENTS RELOADING APPARATUS. Lemsle, G.; Martin, R.; Rouge, P.; Vivien, J. (to Commissariat a l'Energie Atomique). Canadian Patent 766,339. Aug. 29, 1967. Priority date Oct. 6, 1962, France.

The fuel handling assembly described is intended for use in a gas cooled reactor having a solid moderator. A chamber or "garret" above the reactor vessel contains the refuelling machine and is kept at slight positive pressure during normal operation. It consists of a beam mounted to rotate about an axis so that all fuel channels may be reached. The driving mechanism, consisting of two winches designed for remote control, is located outside the chamber. An armored tracked vehicle occupied by an operator may be introduced into the "garret" for fuel removal in the event of a breakdown. (F.S.A.)

12071 FUEL LOADING AND UNLOADING ARRANGEMENT FOR NUCLEAR REACTORS. Aubert, M.; Fortin, G.; Gugenberger, R.; Rouge, P.; Martin, R. (to Commissariat a l'Energie Atomique). Canadian Patent 766,338. Aug. 29, 1967. Priority date Aug. 3, 1962, France.

This fuelling device is intended for use in a gas cooled, graphite moderated reactor. A servicing chamber is disposed inside the pressure vessel and is separated from the reactor core by a wall with closable passages which give access to the fuel channels. A handling system, involving a lock where fuel elements may be held temporarily, exchanges fresh and spent fuel. This is all contained in a tunnel projecting through the reactor vessel. The handling machine has an "orientable arm" which enables transfers between the lock and the fuel storage system. A rather complex method for control from the outside is described. (F.S.A.)

12072 TRIP CIRCUIT. DeLateur, Louis A. (to United States Atomic Energy Commission). U. S. Patent 3,363,149. Jan. 9, 1968.

A magnetic amplifier tripping circuit for a nuclear reactor safety system is described. The circuit generates a trip signal whenever the neutron flux measured by a radiation detector increases faster than a predetermined rate for a given period of time. (AEC)

12073 METHOD OF AND APPARATUS FOR CONTROLLING START-UP OF A NUCLEAR REACTOR. Bunch, Wilbur L. (to United States Atomic Energy Commission). U. S. Patent 3,366,544. Jan. 30, 1968.

A system for controlling a nuclear reactor during start-up to a selected power value is described. Start-up of the reactor is controlled by changing the position of the reactor control rod such as to decrease the difference between the actual time-to-power value of the reactor and a predetermined time-to-power value. (AEC)

Marine and Portable Power Reactors

Refer to abstract 10444.

Rocket and Space Reactors

12074 (NAA-SR-7196) PROGRESS REPORT FOR SNAP SUPPORTING R AND D, JANUARY–MARCH 1962. (Atomics International, Canoga Park, Calif.). July 1, 1962. Contract AT-11-1-GEN-8. 19p. Dep. CFSTI.

Work conducted under SNAP Supporting R & D includes compact power systems analysis, nuclear analysis, critical experiments, shielding analysis and experiments, and thermionic conversion research. Studies have been completed on use of SNAP systems for ion propulsion, thermionic reactor space power, and SNAP 8 terrestrial unit. Construction of the new Critical Facility has started and a safeguards report drafted. (auth)

12075 (NAA-SR-7496) PROGRESS REPORT FOR SNAP SUPPORTING R AND D, APRIL–JUNE 1962. (Atomics International, Canoga Park, Calif.). Aug. 15, 1962. Contract AT-11-1-GEN-8. 23p. Dep. CFSTI.

Work conducted under SNAP Supporting R & D includes compact power systems analysis, nuclear analysis, critical experiments, shielding analysis and experiments, and thermionic conversion research. Several reports on electrical propulsion and thermoelectric space power systems were completed. Reports on recently developed codes and analysis were issued. Construction of the SNAP Critical Facility (Bldg. 012) was completed. (auth)

12076 (NAA-SR-Memo-8844) HEAT LOSS FROM THE SNAP 2 REACTOR PRIOR TO ORBITAL STARTUP. Dufoe, Gene E. (Atomics International, Canoga Park, Calif.). Aug. 15, 1963. 34p. Dep. CFSTI.

Reactor heat losses were calculated for isothermal vessel temperatures of 20, 40 and 60°F and an initial shield temperature of 70°F. The heat loss was also calculated for an isothermal NaK temperature of 40°F and an initial shield temperature of 40°F. Results are shown graphically. (M.L.S.)

12077 (NAA-SR-Memo-12592) TRANSPORT-THEORY ANGULAR QUADRATURE COEFFICIENTS FOR SNAP REACTOR ANALYSIS. Ottewitte, E. H. (Atomics International, Canoga Park, Calif.). Oct. 19, 1967. 21p. Dep. CFSTI.

In SNAP reactor calculations the DP sets should be used in the axial direction. Limited analysis suggests that the SN sets are as good as any in the radial direction. Also, it was found that one should include at least one more significant figure in the quadrature coefficients than is required in the results. (auth)

12078 GAS-CORE NUCLEAR ROCKET ENGINE. Duke, Edward E.; Houghton, William J. (Aerojet-General Corp., Sacramento, Calif.). J. Spacecraft Rockets, 4: 1592-7(Dec. 1967).

Results of studies on major components of gas-core nuclear rocket engines are presented. Core cavity, energy supply, turbopump and centrifugal pumps, and nozzle are described. Pressure vessel characteristics are discussed. Reference characteristics for a gas-core nuclear rocket are tabulated. (M.L.S.)

12079 OPTIMUM CONTROL OF NUCLEAR ROCKETS USING MODELS WITH DISTRIBUTED PARAMETERS. Liu, Tien Chen. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 110p.

Thesis.

The process dynamics of a nuclear rocket are described by kinetics equations having two energy groups and one delayed neutron group. These equations show that the process dynamics of the nuclear rocket form a bilinear system with time and space dependent coefficients. A feedback loop is introduced to compensate for the reactivity feedback which gives time and space dependent coefficients. By using the feedback loop, the process dynamics of the reactor becomes a bilinear system with constant coefficients. Applying the method of separation of variables, the reference control is proved to be independent of the spatial variable for the reference solutions. Optimization minimizes a double integral from the present time to a final time with the sum of the square of the errors as the integrand. By application of calculus of variations, the Euler–Lagrange equations and proper boundary conditions are obtained. The Euler–Lagrange equations with the original perturbed equations are solved by finite Fourier sine transforms. The optimum control laws, both spatial and time varying, are obtained in closed form. The output closely follows the reference solution for arbitrary deviation at any time including that of the initial conditions. (TSS) (Disser. Abstr.)

Process Heat and Desalination Reactors

12080 DUAL-PURPOSE NUCLEAR POWER AND DESALTING PLANT. Wilson, W. H.; Homer, W. A. (Bechtel Corp., San Francisco). Eng. Dig. (Toronto), 9: 32-4(Nov. 1967).

One of the world's largest sea-water conversion plants is to be constructed in Southern California. Based on a feasibility study by the Bechtel Corporation, the projected desalting plant will be located on a man-made island about 2,800 ft offshore from Bolsa Chica State Beach, in Orange County. The plant will have a capacity of 1.5×10^8 gal/day, enough for a population of 750,000. The 40-acre island will be connected to the mainland by a two-lane causeway. (auth)

12081 ECONOMICAL EVALUATION OF ORGANIC MODERATED AND COOLED REACTORS (ROVI) DESIGN TO PRODUCE VAPOR FOR DESALTING PLANTS. Lazzarino, L. (Univ., Pisa, Italy); Di Menza, R. Desalination, 2: 220-6(1967).

The desalination of sea water by large dual purpose nuclear plants producing the greatest possible quantities of water and of electrical energy at the lowest possible cost is discussed. An evaluation study of organic cooled and moderated nuclear reactors (ROVI) specifically designed to operate at low temperature is presented. Economic aspects of that study are presented. For plants requiring installed thermal power between 100 and 400 MW, ROVI reactors are more convenient than other types of steam generators. (TSS) (BBB)

12082 A LARGE-SCALE DUAL-PURPOSE PLANT FOR WATER/POWER PRODUCTION. Clelland, D. W. (United Kingdom Atomic Energy Authority, Risley, Eng.). Desalination, 2: 215-19(1967).

A design study of a dual-purpose power/water plant for the production of 200 MW(e) of power and 377,650 m^3/day of fresh water is presented. The plant comprises a Steam Generating Heavy Water Reactor with associated power plant, together with 8 multi-stage flash distillation units. This reactor is a direct cycle boiling water reactor of pressure tube design moderated by heavy water. An estimate of the overall capital cost of the facilities is given and the cost of fresh water is estimated at a stated power price. (TSS) (BBB)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 10911, 12006, and 12035.

12083 (AECL-2772) LATTICE MEASUREMENTS WITH 28-ELEMENT NATURAL UO_2 FUEL ASSEMBLIES. PART II. RELATIVE TOTAL NEUTRON DENSITIES AND HYPERFINE ACTIVATION DISTRIBUTIONS IN A LATTICE CELL. Serdula, K. J.; Green, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug. 1967. 64p. Dep. CFSTI. CAN $1.50.

Relative total neutron densities and hyperfine manganese activation distributions have been derived from measurements in a triangular array of 55 28-element natural UO_2 fuel assemblies in D_2O moderator. Results are presented for lattice pitches in the range 20 to 40 cm. Simulated "coolants" used were: D_2O of moderator purity, air to simulate loss of coolant condition, and an organic liquid, HB-40. The results show that the total neutron density depression across the cell is smallest for air and largest for organic (HB-40) coolant, as expected from the absorption and scattering properties of the coolant materials. 11 references. (auth)

12084 (BAW-3647-6) PHYSICS VERIFICATION PROGRAM. PART II. Quarterly Technical Report, July–September 1967. Baldwin, M. N.; Clark, R. H.; Rogers, J. E. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Dec. 1967. Contracts AT(30-1)-3647; 41-2007. 44p. CFSTI.

A description of the critical assembly, used for in-core checking of an all-solid, self-powered in-core neutron detector for power reactors, is described. A brief description of the detector is given. Axial traverse measurements of integrated charge, which is proportional to flux, are described; values are listed. Fission density measurements are presented as a function of detector signal. Normalized power distribution measurements are tabulated. Use of rhodium wires for calibration of the detector is detailed. 12 references. (M.L.S.)

12085 (BNWL-472, pp 3.1-33) THERMAL REACTORS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Measurements to obtain adjoint weighted excess neutron production cross sections were completed for four lattices of PuO_2–UO_2 fuel in graphite moderator. The measurements were made in the Physical Constants Test Reactor (PCTR), and a value of the infinite medium neutron multiplication factor (k_∞) was obtained for one lattice using the traditional PCTR null reactivity technique. This value of k_∞ was compared with the corresponding value obtained from measurements for the same lattice. Analysis of the CAF-Phoenix water reflected core with 17 energy groups yielded a calculated reactivity within 1% of experiment using diffusion theory and 3% using transport theory. Pre-experiment calculations on the PRCF-Phoenix core revealed that k dropped as more core-reflector interface detail was added. Final critical loading estimates were less than 9% low. Placement of flux suppressors for the MTR-Phoenix core was investigated to avoid having the far-out flux increases outweigh the close-in flux decreases. A full-core banked-shim critical loading was achieved in the PRCF-Phoenix fuel experiment, with the shims 65% withdrawn. Power distribution measurements in the shimmed core have shown the expected power peaking in the fuel followers just below the bottom of the core. Compilations have been issued of the burnup data obtained by destructive analysis of Al-1.8 wt % Pu and Al-2.6 wt % Pu fuels which were irradiated in PRTR. Analysis of the burnup data from the Aluminum–Plutonium fuels irradiated in PRTR was completed. The isotopic concentration data were processed using multivariable regression analysis to obtain a unique set of cross section ratios. An empirical formula was derived for use in fitting critical mass data from cylindrical arrays of rods, moderated with H_2O. The formula provides a method of accurate interpolation to obtain the fuel-to-moderator ratio for minimum critical mass. Relative rod power measurements were made in PRTR to determine the power match between fuel rods in elements in the Batch Core and fuel rods in several possible test configurations in the Fuel Element Rupture Test Facility (FERTF). The relative rod powers were determined by gamma scanning. The reactivity changes associated with loss of coolant from the PRCF were also measured for several fuel compositions and test configurations. A theory-experiment correlation study of ratios of effective cross sections was performed. A result of the study is that the calculated ratios agree best with the experimental ratios using the Leonard normalization for the ^{239}Pu and ^{241}Pu thermal cross sections. Calculations of the photoneutron production in D_2O moderated reactor systems fueled with 19-rod clusters of Al–Pu, UO_2–PuO_2, and UC were made. A calculational study was made comparing values of the Dancoff correction obtained via various methods. The corresponding effect of resonance integrals and reactivity were also determined. Calculations were made of power peaking factors in H_2O moderated loadings of UO_2-2 wt % PuO_2 fuel. The calculated values agree with measured values to within ±5%. Calculations were performed to help predict critical masses and various lattice parameters for H_2O moderated lattices containing UO_2-4 wt % PuO_2 fuel rods. The study was made assuming two types of fuel differing in ^{240}Pu content. (auth)

12086 (BNWL–472, pp 4.1–43) FAST REACTORS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A survey was performed to investigate the effect of BeO on FTR neutronics. Items considered included the sodium coefficient, Doppler coefficient, critical mass, and flux spectrum dependence on BeO volume fractions. A detailed analysis of FTR control rod configurations was carried out. A variety of representative rod patterns were examined and their reactivity worth determined. The effects of fuel failure and fuel relocation (slumping) in the FTR are being re-examined. A series of kinetics calculations were performed for a range of reactivity ramps and shutdown coefficients. The possible utilization of fuel-rod plugs to minimize the effects of fuel slumping was also considered. To check calculational techniques used in FTR design, analysis of the sodium void experiments performed on the SEFOR mockup in ZRP-III was undertaken. A fairly detailed analysis of the Doppler coefficient measurements in the same assembly is also being carried out. Incorporation of crystalline binding effects in the analysis caused the Doppler coefficient to diverge from the 1/T dependence in qualitative agreement with the experimental results. The two-dimensional perturbations code, 2-D PERT, is not operational. This code will be used for driver fuel and test management studies. The Phase-A critical experiments in ZPR-III were completed, and analysis of the experiments was started. The attenuation characteristics of a number of alternate shield arrangements were compared analytically to provide a basis for the conceptual design of the FTR. Estimates of gamma intensity at selected locations within two different closed loop cell concepts were also made. (auth)

12087 (BNWL–472, pp 5.1–16) CRITICAL MASS PHYSICS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Criticality experiments, bare and water reflected, were continued with the 42 × 42 in. slab assembly having adjustable thickness. The plutonium concentration was 58 g/liter and acid molarities were 2.3 and 5. The plutonium contained 4.6 wt % ^{240}Pu. Evaluation of the effect of vessel walls, lattice reinforcement, and hood walls was made. Correlation of slab experimental data and initial calculation theory were in poor agreement. The clean critical bare and water reflected infinite slab was experimentally estimated to be 15.7 and 10.1 cm respectively for 58 g Pu/liter at an acid molarity of 2.3. Criticality experiments were performed to provide data for nuclear safety guidance on handling, storing, and shipping of United Kingdom nut type casks containing 6.6 kg plutonium metal each. Experiments were carried out with the nine casks bare and reflected with Lucite. Effect of Lucite moderator and cadmium plating was studied qualitatively. The bare array indicated criticality at about 19 casks; the reflected array gave 10½ casks for criticality. Critical bucklings and masses were measured for a range of lattice spacings of 2.1 wt % enriched U fuel tubes in light water. Criticality experiments were performed in support of the Gas Cooled Fast Breeder Reactor (GCFR) program. The experiments were designed to simulate water entry into the GCFR core and to check basic neutronic data and computational techniques. An experimental program to provide data for determining the minimum critical ^{235}U enrichment of hydrogenous uranyl nitrate systems was completed in the PCTR. Data reduction and analysis are currently in progress. Some experimental results are presented as raw data. The dead time problem connected with Rossi-alpha measurement using multi-channel equipment was circumvented by using, essentially, a multiple single channel approach. A system was assembled employing fast solid state equipment in hope that it will be useful for epithermal and fast neutron systems. A system for experimentally measuring the P_0 probability of reactor noise for various time intervals was assembled in hopes of providing an independent measurement of the prompt neutron decay constant. A new series of critical experiments was begun at the Critical Mass Laboratory with PuO_2-polystyrene compacts and the Remote Split-Table Machine. These experiments are a continuation of the basic research program to provide data for evaluating the effects of moderation and ^{240}Pu on intermediate neutron spectra plutonium systems. The current series of experiments are concerned with fuel having an atomic H/Pu of 5 and a ^{240}Pu isotopic content of 11.5 wt %. (auth)

12088 (BNWL–569) TRIP REPORT: U. S. FFTF FUELS AND MATERIALS TEAM TRIP TO THE UNITED KINGDOM AND FRANCE. Claudson, T. T.; Peterson, R. E.; Hanson, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 125p. Dep. CFSTI.

The information and data on the fast reactor fuels, materials, and core design technology obtained at British and French research installations which could be of value to the Fast Flux Test Facility (FFTF) project are presented. Emphasis is placed on information that may aid decisions on the FFTF reference fuel, cladding and structural materials, and core design parameters. (H.D.R.)

12089 (BNWL–594) FFTF CRITICALITY SAFETY SYSTEM 72: UNDERWATER EXAMINATION FACILITY FEASIBILITY OF USING A SOLUBLE POISON FOR CRITICALITY CONTROL. Brown, C. L.; Lawrence, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1967. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

Safety of underwater disassembly of FFTF fuel pins is examined. Use of B, in the form of Na_3BO_3, is evaluated. Minimum concentration to assure criticality safety is calculated. (M.L.S.)

12090 (BNWL–595) FFTF CRITICALITY SAFETY SYSTEM 72: UNDERWATER EXAMINATION FACILITY CONCEPTUAL DESIGN EVALUATION. Brown, C. L.; Lawrence, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 11p. Dep. CFSTI.

Each FFTF system that is to involve the handling, storage, or transporting of fissile material will be evaluated for criticality safety during the conceptual, preliminary, and final design stages. Wherever necessary, special controls will be recommended to assure criticality safety. The conceptual design of the Underwater Cell Examination Facility (System 72) is reviewed and guidelines for criticality safety in this facility are given. (auth)

12091 (BNWL–639) FAST FLUX TEST FACILITY DEVELOPMENT MONTHLY PROGRESS REPORT, NOVEMBER 1967. Woodfield, F. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 10, 1967. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

Development of in-line instrumentation for sodium purity

measurements throughout the USA are discussed with reference to FFTF needs. Determination of heat transfer characteristics of FFTF fuel assemblies is discussed. The FTR hydraulic core mockup is detailed. Results of deceleration tests are shown graphically. Data on reactor environmental effects on signal cables are given. Results of postirradiation testing of AISI-304 stainless steel are discussed. Relative flux spectral shapes are given for the EBR-2, FTR, DFR, and ETR for energies greater than 100 eV; these are compared to a Watt spectrum. (M.L.S.)

12092 (CEA-R-3354) MASSE CRITIQUE, VALEUR DES BARRES ET COEFFICIENTS DE REACTIVITE DE RAPSODIE. (Critical Mass, Rod Values and Reactivity Coefficients for Rapsodie). Stevens, Lesli; Gourdon, Jean (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Oct. 1967. 46p. (In French). Dep.

Besides a brief general description, a description and discussion of the aims, the methods used and the results of critical mass, rod worth and static reactivity coefficient measurements on the RAPSODIE reactor are given. (auth)

12093 (EUR-3654) SOME PROBLEMS OF STRESS WAVE PRODUCTION ENCOUNTERED IN THE STUDY OF PULSED FAST REACTOR DYNAMICS. Randles, J.; Jaarsma, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Sept. 6, 1967. 47p. Dep.

The thermoelastic response of the fuel element and cladding due to the rapid fuel temperature rise during a pulse are presented. A theory describing this response for any form of fuel temperature input is given and then applied to the special case of a discontinuous temperature rise and a ramp rise in temperature. It is proved that, because of the short timescale of a pulse, the stresses developed in the fuel and cladding are insensitive to the detailed form of the temperature rise and can be calculated accurately by assuming a step function. The stresses in the cladding are shown to be greater than those in the fuel, an accidentally large fuel temperature rise of about 180°C in a SORA type reactor being capable of breaking the cladding. Sustained pulsed operation with a temperature rise of about 70°C would cause fatigue in the cladding, demonstrating that the proposed figure of ~1°C for normal operation in SORA lies well within the fatigue limit. The need for a thorough study of the internal dissipative effects in the fuel material is demonstrated. The ejection of the liquid metal coolant from the core of a pulsed fast reactor during the hypothetical collision of a broken fragment of the pulsation device is also considered. It is shown that the amplitude of core compression caused by this collision is strongly dependent on the transit time of acoustic waves (in the coolant) along the compressed length of core. The change in core volume is shown to precisely the above transit time. This equation is solved numerically for a variety of conditions and the enhancement in the amplitude of core compression due to the ejection process is obtained over a wide range. 9 references. (auth)

12094 (IN-1126) NUCLEAR TECHNOLOGY BRANCHES QUARTERLY REPORT, APRIL 1-JUNE 30, 1967. (Idaho Nuclear Corp., Idaho Falls). Dec. 1967. Contract AT(10-1)-1230. 20p. Dep. CFSTI.

Irradiation studies to determine the errors in measuring fission rates and fuel element powers in ATRC have been completed. The contributions of wire positioning, fuel element positioning, beta counter precision, and wire nonuniformity to measuring errors are discussed, and the error values reported. Conditions responsible for systematic errors in the boron assaying of ETR and ATR fuel elements are discussed, and a summary of assayed boron contents is reported. Further results of ETRC measurements to examine the effects of rod travel on midplane fission rates are reported. Experiments to determine ARMF regulating rod transient time have led to the adoption of new operating procedures to improve reactor operating efficiency. The results are given for fast-chopper cross section measurements which have been continued on Pm-147. Newly determined activation cross sections of Am-243 to 10.1-hr, Am-244 and to both isomers are reported. Results also are tabulated for recently determined energies and absolute intensities of 2.1-day Np-238 gamma rays. Additional information is provided on the yields of I-135 of the common fissile isotopes relative to the yields of U-235. (auth)

12095 (EURFNR-285) DETERMINATION OF PHYSICAL REACTOR PARAMETERS FROM REACTOR NOISES, BY PROBABILITY-DISTRIBUTION ANALYSIS. Stegemann, Dieter H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-542. 77p. Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Use of neutron noise analyses for determination of reactor parameters is discussed. The probability distribution method is investigated. Theoretical bases for this approach are established; application to the STARK fast-thermal Argonaut reactor is detailed. (32 references). (M.L.S.)

12096 TEN YEARS JUBILEE OF THE NUCLEAR RESEARCH REACTOR IN THE INSTITUTE OF NUCLEAR RESEARCH OF CZECHOSLOVAK ACADEMY OF SCIENCES. Musilek, F.; Capek, M. Jad. Energ., 13: 445-7(1967). (In Czech).

A brief general discussion is given on the construction, performance, operational techniques, and efficiency of the first WWR-S reactor in Czechoslovakia. (R.V.J.)

12097 POWER FLUCTUATIONS INDUCED ON AN ARGONAUT TYPE REACTOR BY ELECTROLYTIC BUBBLES. Ameglio, P. (Univ., Genoa); Brighenti, G.; Chiodi, P. L.; Magrini, U. Energ. Nucl. (Milan), 15: 44-6(Jan. 1968).

The use of a pile oscillator to measure reactivity fluctuations in the inner thermal column of the RB-2 is discussed. The use of an electrolytic cell to produce voids, thereby causing reactivity changes, is described. A description of the electrolytic cell, and associated electronic equipment, is given. (N.L.S.)

12098 IN-PILE FACILITY FOR CORROSION AND WATER CHEMISTRY EXPERIMENTS. Cerrai, E.; Gadda, F.; Morandi, G.; Scaroni, A. (CISE Labs., Milan). Energ. Nucl. (Milan), 15: 24-9(Jan. 1968).

An in-pile facility for corrosion and coolant-chemistry experiments for water-cooled reactors is described. The loop, which is located on the Avogadro swimming pool reactor held by SORIN, has been operated for more than 13,000 hours, of which about 8000 were performed for in-pile tests. (auth)

12099 CORRELATION EXPERIMENTS IN NUCLEAR REACTORS BY DIGITAL MEASUREMENT OF COUNTING RATES. Robinson, E. (Institut fuer Reaktorphysik der GKSS, Geesthacht, Ger.). Atomkernenergie, 13: 8-12(Jan.-Feb. 1968). (In German).

A digital analysis of pile noise is reported in which data are determined by measurement of time-dependent counting rates with a multichannel analyser. Data reduction is made with a digital computer. The influence of this method of determining data on the form of the correlation functions (autocorrelations function and power spectral density) is described. Pile noise analysis is treated within the limitations of the point reactor model. Counting rate measurements were applied in experiments in a zero power assembly FRG-O, a swimming pool type reactor. 9 references. (auth)

12100 SOME PROBLEMS PERTAINING TO THE USE OF THE VERTICAL BIOLOGICAL CHANNEL OF THE WWR-M NUCLEAR REACTOR. Kaminker, D. M.; Mezzhukhim, A. S.; Postnikov, L. N.; Sverdlov, A. G. Radiobiologiya, 7: 462-4(1967). (In Russian).

A vertical channel for biological experiments in a nuclear reactor presents advantages in comparison with a horizontal channel. Its diameter can be made much larger, so that large animals like dogs and sizeable groups of small animals can be irradiated. A vertical channel with dimensions of 400 × 600 mm has been built into the concrete shielding of a WWR-M reactor at a distance of approximately 1.5 m from the reactor core. The channel has been equipped with a chamber which is adapted to the irradiation of animals. This chamber is provided with Pb neutron filters which make it possible to vary the ratio between the γ- and neutron components of radiation. (JPRS)

12101 LOW CRITICAL MASS. Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Appl., 4: 17-18(Jan. 1968). (LA-DC-8884).

Criticality parametrics for enriched fissionable reactor fuel in water have been extended to the effects of thick moderator reflectors, with emphasis on beryllium. The result was a minimum critical mass one-third of that in the water reflected assembly. (auth)

12102 EFFECT OF SOURCE DISTRIBUTION ON NEUTRON RESONANCE INTEGRALS. deLoach, A. C.; Suich, J. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng., 31: 163-7(1968).

A comparison of techniques for calculating effects of source distribution on neutron resonance integrals is made; the assumptions of spatially flat neutron distribution is compared to a spatially dependent source flux. A method for estimation of error associated with a flat flux approximation is given. 14 references. (M.L.S.)

12103 EFFECTS OF NEUTRON IRRADIATION ON THE MAGNETIC SHIELDING MATERIAL FOR A REACTOR BEAM HOLE. Dobrozemsky, R.; Kerschbaum, E. (Oesterreichische Studiengesellschaf fuer Automenergie, GmbH, Seibersdorf,

Austria). pp 363-7 of Proceedings of the Second International Conference on Magnet Technology, Oxford, England, 1967. Hadley, H. (ed.). Chilton, Eng., Rutherford Laboratory, 1967.

See CONF-670705.

Vacodur 16 and M 1040 were found to give values of 2000 to 3000 for the initial permeability after irradiation doses up to 6×10^{18} nf(0.1) cm^{-2} ($E_n > 0.1$ MeV), even after some mechanical pre-irradiation treatment. Samples without such treatment, i.e., with optimum properties at the beginning of the irradiation, should remain usable up to even higher doses. Under these conditions Mu Metal may also give good results. (auth) (UK)

12104 RELAY CONTROL OF THE UNIVERSITIES' RESEARCH REACTOR. Jeffers, D. E. (Univ. of Manchester, Eng.); Matin, A.; Lynn, J. W. Proc. Inst. Elec. Eng. (London), 114: 1787-92(Nov. 1967).

The 2-zone core of the Universities' research reactor was simulated on an analogue computer, and the average flux signal from the analogue was used to drive an "on-off" autocontroller with a deadband. On completion of the analogue tests, the controller was installed on the reactor, and the same series of tests repeated. Good agreement was obtained between the analogue and reactor results, and the equipment is in permanent use on the plant. (auth)

12105 MEASUREMENT OF SPACE-DEPENDENT REACTOR TRANSFER FUNCTION OF SHE CRITICAL ASSEMBLY BY PILE-OSCILLATOR METHOD. Hoshino, Tsutomu; Yoshikawa, Hidekazu; Wakabayashi, Jiro. Tech. Rep. Eng. Res. Inst., Kyoto Univ., No. 134, 1-16(Oct. 1967).

Space-dependent transfer function of SHE critical assembly (zero-power, graphite moderated UO_2 thermal assembly) is measured by using pile oscillator method. Detected neutron pulses are input into multi-channel time analyzer and Fourier analysis for the fundamental wave of reactivity modulation is made on the output. The amplitude of the transfer function is expressed in modulation ratio of the fundamental wave in the modulated flux. In Fourier analysis calculation the processes uncorrelated to the reactivity modulation do not make appreciable contributions to the results. Results show a space-dependence of transfer functions in the higher frequency region than the break point frequency. (auth)

12106 FULLY AUTOMATIC RABBIT SYSTEM FOR IRRADIATING AND COUNTING SHORT-LIVED ACTIVATION PROBES. Backfisch, W.; Bayer, A. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 9: 493-8(Nov. 1967). (In German).

A specially designed pneumatic rabbit system for STARK is described. The rabbit system is designed for irradiating and counting short-lived activation probes; counting can be done 3 seconds after irradiation. The construction and cycle of operation of the automatically opening rabbit is detailed. The electronic control of the system and coupling to the gamma counting system are described, also. (M.L.S.)

12107 RESEARCH REACTOR EXPERIMENTAL TECHNIQUES. Proceedings of a Study Group Meeting held by IAEA at Bucharest 26–31 October 1964. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. 558p. (CONF-791). DTIE.

A review of experimental facilities and procedures for research reactors is presented. Separate abstracts are presented for thirty-one of the thirty-two included papers. One paper has previously been presented in NSA as 19: 3779. (D.C.C.)

For abstracts of individual papers see: 12037, 12108–12135, 12144, and 12145.

12108 REACTOR PHYSICS EXPERIMENTAL TECHNIQUES USED IN THE UTILIZATION OF RESEARCH REACTORS. Raisic, Nenad (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 3-30 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A review of routine reactor physics experimental techniques used in the utilization of research reactors is given. The first part presents the techniques used for measuring neutron fluences and energy absorbed from reactor radiation. For absolute and relative measurements of neutron fluences, and flux densities in various energy ranges, use of foil activation techniques, ionization chamber technique and semi-conductor counter technique is described. A summary of the methods is given of obtaining data for the temperature of the Maxwell spectrum and indication of the shape of fast neutron energy distribution by in-pile measurement. A special emphasis is given to the interpretation of experimental results, sources of error and the corrections applied. The practical utilization of the obtained results is discussed. The techniques for measuring the energy absorbed from reactor radiation are described such as the ionization chamber; calorimeter and chemical dosimeter techniques. The main difficulties in these methods of measurement are stressed and the accuracy of the obtained results for different application is analyzed. The second part presents the routine techniques used for reactivity measurements. Only those techniques are described which do not require any additional instrumentation but acceptable results can be obtained with standard reactor instrumentation. The method can be used for determining the reactivity worth of control, shim and safety rods and built-in reactivity. The main emphasis is given to the techniques applied in the determination of large negative reactivities. The possibilities of standardizing routine reactor parameter measurements, as recommended by various IAEA symposia, are discussed. (auth)

12109 REACTOR PHYSICS ASPECTS OF THE HARWELL RESEARCH REACTORS. Wade, B. O. (Atomic Energy Research Establishment, Harwell, Eng.). pp 31-52 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The reactor physics considerations necessary to ensure the safety and efficient utilization of the Harwell high flux research reactors and to support the design of experiments and their analysis are reviewed, including the formulation of reactivity balances, flux monitoring techniques, and the treatment of flux depressions. The use of a zero energy reactor to assist in the design of experiments and to give insight into the physics of the high flux reactors is discussed. The need for high speed digital computing in these various fields is assessed. (auth)

12110 A REVIEW OF IN-PILE DOSIMETRY TECHNIQUES USED IN RA AND RB RESEARCH REACTORS AT VINCA. Raisic, N.; Draganic, I.; Radak, B. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). pp 53-61 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A review of experimental techniques for in-pile dosimetry of neutron and gamma rays, used at Boris Kidric Institute is given. As a standard procedure for absolute and relative neutron flux measurements the foil activation techniques are applied. For thermal neutron flux absolute measurements Au and Co foils are used. The epithermal component in the neutron flux is characterized by the epithermal index r, which is determined by measuring the Cd ratio of various resonance detectors. The fast neutron fluxes in the experimental tubes and inside the hollow fuel elements are determined by threshold detector activation such as S, P, Ni, Mg and Al. The effective cross sections for the threshold detector are determined by integrating the calculated fast neutron spectrum over the $\sigma(E)$ curve. In addition to the foil activation a description is given of the fission chamber and semiconductor counter measurement techniques for the thermal and fast neutron flux plotting inside the reactor core. As a suitable method for absolute measurements of both thermal and fast neutron fluxes inside a high flux operating core, the "long-tube" method originally developed at the Boris Kidric Institute is described. It is based on semiconductor counter measurement in an arrangement where the target is separated from the counter. For the measurement of the pile radiation absorbed doses the calorimetric techniques using both isothermal calorimeters with thermistor and differential calorimeter with three bodies are described. The typical results of measurements of neutron and absorbed doses in the RA reactor are given. (auth)

12111 USE OF A CRITICAL ASSEMBLY IN OBTAINING DATA FOR INSTALLING A FLUX TRAP IN A RESEARCH REACTOR. Strugar, P.; Raisic, N.; Obradovic, D.; Iovanovic, S. (Boris Kidric Inst. of Nuclear Science, Belgrade). pp 63-70 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In Russian).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The fuel elements of the RA heavy water 7 MW research reactor at the Boris Kidric Institute of Nuclear Sciences in Belgrade are composed of a number of individual slugs. A study was made to install a flux trap in the central part of the reactor by dividing the core in two parts and to form a central horizontal reflector. To determine the flux gain and the reactivity loss as a function of the central reflector thickness and the lattice pitch, experiments were performed on the RB heavy water zero power reactor. The experiments were preceded by calculations using two-group diffusion theory, and the rough indication of the investigated changes ob-

tained. The results of the experiments have shown a slight gain in the thermal neutron flux with the present RA reactor lattice pitch of 13 cm. The significant increase is obtained with smaller lattice pitches of about 10 cm, and the optimal core arrangement is found for the reflector thickness of about 20 cm. (auth)

12112 INFINITE MULTIPLICATION FACTOR MEASUREMENTS BY RB-1 REACTOR. Casali, F. (CNEN, Bologna). pp 71-83 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The RB-1 reactor has been designed to measure the infinite multiplication factor of power thermal reactors by studying the properties of a small amount of multiplying material. Some experiments performed during the past year to measure k_∞ of two lattices are described. It is concluded from these experiments that, at least for particular lattice used, k_∞ can be measured with 3 to 4% of accuracy using only a 60 cm × 60 cm × 80 cm section of the lattice. (auth)

12113 EXPERIMENTAL VERIFICATION OF A REMOVAL AGE-DIFFUSION MULTIGROUP PROGRAM IN A THERMAL COLUMN. Zerdin, F.; Dimic, V. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia). pp 85-92 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A removal age-diffusion multigroup programme with only four energy intervals in the removal group for a bulk shield was experimentally verified in the thermal column of the heavy water experimental 6.5 MW reactor in Vinca. Thermal and epithermal neutron fluxes were measured in a usual manner by using bare and Cd covered Au and In foils. The measured Cd ratio is accurate in the high flux region close to the reactor core. In the low flux region the experimental accuracy was not sufficient to get reliable results. The measured and calculated values of R_{Cd} are in agreement within limits of experimental errors. The relative values of the calculated and measured thermal fluxes agree satisfactorily all the way through the thermal column, except at the outer face. The absolute values disagree due to normalization uncertainties. (auth)

12114 REACTOR KINETICS, EXPERIMENTAL TECHNIQUES. Magnuson, Dale W. (International Atomic Energy Authority, Vienna). pp 95-114 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Selected topics in reactor kinetics are described with emphasis on the experimental methods and necessary calculations used for the interpretation of the time dependence of neutron populations. The application of pulsed neutron reactivity measurements to the zero power experiments for the Oak Ridge High Flux Isotope Reactor is presented in detail to illustrate usefulness in reactor design. The utilization of reactivity oscillations and reactor noise spectrum measurements to determine transfer functions is discussed along with other methods of analysis of statistical fluctuations. (auth)

12115 ON SOME RELATIONS BETWEEN THE KINETIC TECHNIQUES EMPLOYED AT THE RESEARCH REACTORS. Purica, I. (Inst. of Atomic Physics, Bucharest). pp 115-29 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In French).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Critical considerations regarding the possibilities of the kinetic techniques using research reactor neutron beams (neutron waves propagation, frequency response method, pulsed source method) for material analysis are presented. Also presented are the experimental results obtained at the Institute of Atomic Physics in Bucharest. (auth)

12116 PULSED NEUTRON MEASUREMENTS OF THE KINETICS PARAMETERS ON A RESEARCH REACTOR. Petrovic, M.; Velickovic, Lj.; Markovic, V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 131-41 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The procedures using the pulsed neutron techniques for measuring kinetics parameters of the heavy water zero power research reactor RB are described. Results for safety analysis of a research reactor are discussed. (auth)

12117 EXPERIMENTAL TECHNIQUES FOR IN-PILE IRRADIATION EXPERIMENTS. Merrett, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 145-65 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Descriptions of irradiation experiments in the BEPO reactor include fissile materials, non-fissile materials, release of gaseous fission products, creep and dimensional charges, neutron diffraction studies, and cryogenic equipment. Each type of experiment employs its own specialized apparatus which has gradually evolved into a high state of development. Problems include: fabrication problems on unusual materials, compatibility problems, materials joining including welding and brazing, the need for reconciling several conflicting requirements, sealing, maintenance of high vacuo, thermal insulation, pumping of fluids, gas purification, small in-pile heaters, and temperature measurement. Solutions of the problems are presented. (auth)

12118 SOME ASPECTS ON EXPERIMENTAL TECHNIQUES AND EQUIPMENT FOR IN-PILE IRRADIATIONS. Swenson, Bengt (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 167-72 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Questions concerning in-pile test loops, with application to some typical test programmes, and aspects on other types of in-pile irradiation such as high temperature fuel studies and irradiation of fuel and structural material in rigs and in special rabbit systems are discussed. Safety principles for design, construction and operation of equipment are discussed, as well as problems encountered in the installation of equipment in the reactor core and the interaction with reactor operation. Various techniques for achieving the desired test environment are studied and also the optimization of an experiment with regard to test volume, useful flux, and planned life of equipment. (auth)

12119 ENGINEERING FACILITIES FOR THE IRRADIATION IN THE VVR-SZ REACTOR IN BUDAPEST. Istvan, Peter; Lajos, Varkonyi (Central Inst. for Physical Research, Budapest). pp 185-209 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In French).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The radiations in the area of the reactor core and reflector are used in radiation chemistry, activation analysis and radioisotope production. Specially designed irradiation facilities have been developed and are either still in operation or have been in operation in 1964. An organic loop in the core of the reactor has been in operation for 2000 hours and a temperature of the order of 350°C in the loop by means of electric heating has been maintained. Samples irradiated in the reactor are transported to the laboratory for activation analysis by means of a pneumatic conveyor. Exposure-time is controlled automatically and the actual transfer time is approximately 5 seconds. Uniform total exposure is ensured for simultaneously irradiated samples by arranging them on a revolving holder. A flux-trap has been prepared for exposures necessitating a large thermal-neutron flux in the reactor core. A multi-level, separated exposure channel allows for production of isotopes and other exposure requirements. The review contains an account of the various aspects of the design of the facilities, technical specifications and practical results of irradiations. (auth)

12120 SUMMARY OF IN-PILE LOOPS AT THE JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Ohmori, E.; Ishii, T.; Hara, R. (Japan Atomic Energy Research Inst., Tokyo). pp 211-24 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Loops installed at JRR-2(10 MW, CP-5 reactor) and JRR-3 (10 MW, natural uranium-heavy water reactor) of Tokai Research Establishment of Japan Atomic Energy Research Institute are reviewed. These loops include: loops for irradiation tests, liquid N loop, liquid He loop, fission gas loop and chemonuclear loop. (auth)

12121 LOW TEMPERATURE NEUTRON IRRADIATIONS IN THE GRENOBLE NUCLEAR RESEARCH CENTER. Bochirol, L. (CEN, Grenoble, France). pp 247-69 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In French).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The cryogenic irradiation facilities of the MELUSINE and SILOE pool reactors are described. Experimental studies include: investigations of resistivity, magnetic trainment, the energy stored within metals, pure or alloys (Fe–Ni); radiation effects on uranium grain growth and on disordering the alloy U–Mo; and dimension changes, resistivity, and the energy stored in graphite. (D.C.C.)

12122 CRYOGENIC EQUIPMENT AND TECHNIQUES FOR IRRADIATION AT LOW TEMPERATURES AND FOR PRODUCTION OF COLD NEUTRONS AT THE FR2 KARLSRUHE. Marth, W. (Nuclear Research Center, Karlsruhe, Ger.). pp 291-6 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Low temperature irradiation equipment is being built at the FR2 for studies of radiation damage in metals. It will enable irradiation of specimens in the core of the reactor and subsequent investigations at selected temperatures between 15 and 300°K. Essential parts of the facility are a two-stage, oil-free piston compressor, a heat-exchanger consisting of concentric copper pipes, a one-stage, two-cylinder expansion engine (Collins), a gas storage vessel with pressure control and an automatic vacuum equipment. Cooling medium is gaseous helium. Essential data are: gas flow 500 Nm^3/h; gas pressure 22 and 3 ata, temperatures (at the expansion engine) 20 and 12°K. A second experiment will permit the measurement of total and differential cross-sections and the study of the dynamics of liquids and solids. These investigations are done with "cold" neutrons at an energy range below 5 MeV. The equipment utilizes a horizontal beamhole extending into the reflector zone of the N-cooled neutron filter, a mechanical neutron velocity selector (which can easily be replaced by other means of energy discrimination such as time-of-flight equipment), a vacuum and a refrigeration system. (auth)

12123 FACILITIES AND EXPERIMENTAL TECHNIQUES: THE CHEMIST'S NEED IN RESEARCH REACTORS. Meinke, W. W. (National Bureau of Standards, Washington, D. C.). pp 299-306 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Chemical problems involving a research reactor can be broken down into five general categories: nuclear chemistry, activation analysis, "hot" atom chemistry, radiation chemistry, and the production of isotopes. Many different types of irradiation facilities can be used for each but it is usually important that conditions of irradiation be well defined. Since the irradiation facilities often provide the key to progress, the capabilities of special types of reactor irradiation facilities often provide the key to progress, the capabilities of special types of reactor irradiation facilities in each of these areas are discussed. (auth)

12124 SUMMARY AND REMARKS ON SAMPLE IRRADIATIONS BASED ON THE EXPERIENCES AT JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Ohmori, E.; Hara, R. (Japan Atomic Energy Research Inst., Tokyo). pp 307-19 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Irradiations of samples of different natures are reviewed based on the experiences with JRR-1 (water boiler reactor) and JRR-2 (10 MW, CP-5 reactor). A general guide for the acceptance of samples for irradiations, special cases of irradiations such as irradiations of animals, gases and liquids, and bulky samples, and a few typical problems encountered in the irradiations are described. Representative samples irradiated to date are tabulated, and the importance of exchange of information on sample irradiations and irradiation techniques is stressed. (auth)

12125 RECENT ADVANCES IN TECHNIQUES FOR REACTOR BEAM EXPERIMENTS. Saunderson, D. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 323-43 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A survey is made of recent advances in the methods used in reactor beam experiments. Topics reviewed include: the enhancement of low energy fluxes by rethermalization in cold moderators; the complementary technique for high energy fluxes using heated source blocks; the use of polycrystalline and single crystal filters to shape emerging beam spectra; and the use of total reflection for preferential low energy filters, neutron conducting beam tubes and polarizers. The choice of materials and parameters of single crystal monochromators is discussed in relation to resolution and intensity. Certain features of the design and operation of present triple axis crystal spectrometers, including the application of focussing conditions to improve phonon peak intensities, are considered. In the field of time-of-flight spectrometry topics discussed include the use of phased chopper systems with high energy resolution for inelastic neutron scattering measurements, and methods of data accumulation and analysis. A brief discussion is given of the factors governing the choice of neutron detectors under different experimental and background conditions. (auth)

12126 CONSTRUCTION AND PERFORMANCE OF THE LIQUID HYDROGEN MODERATOR AT FiR-1. Tunkelo, E. (Inst. of Tech., Otaniemi, Finland). pp 345-55 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Construction of the liquid hydrogen moderator which is installed in a tangential through-going beam tube of the TRIGA MARK II reactor is described. Operation of the loop and control of the cooling, including safety factors involved, is described. The performance of the moderator is shown in terms of neutron spectra from the moderator when it is filled with water at room temperature, with nitrogen gas at 77°K, with hydrogen gas at 77°K, and with liquid hydrogen at 20°K. (auth)

12127 MECHANICAL CHOPPERS FOR THERMAL AND RESONANCE NEUTRONS USED AT THE VVR-S EXPERIMENTAL MEDIUM POWER REACTOR. Dobrescu, S.; Marinescu, L. (Inst. of Atomic Physics, Bucharest). pp 377-84 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In French).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

Two choppers, that cover a large neutron energy range (0.001 eV to 10 keV) in conditions of a good resolution and a great luminosity have been constructed. The thermal neutron chopper (0.001 to 1 eV) consists of a rotor that has two sandwiches of different width straight slots. The fast chopper (0.05 to 10,000 eV) consists of a 40 cm diameter rotor mounted between two movable collimators. The effective width of the chopper slots can be varied between 0.2 to 1.25 mm. Some experimental results of the measurements made with these instruments are presented. (auth)

12128 EXPERIMENTAL METHODS FOR EXPERIMENTS ON NEUTRON SCATTERING BY LIQUIDS AT THE HORIZONTAL CHANNEL OF THE VVR-S REACTOR. Bally, D. (Inst. of Atomic Physics, Bucharest). pp 385-400 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In French).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The optical characteristics of crystal and time of flight spectrometers for neutron scattering experiments in gases and liquids are presented. The following problems are discussed: the possibility to obtain tailored beam of neutrons by total reflection of neutrons on Soller collimator sheets; the influence of collimator parameters on the resolution and luminosity of crystal spectrometers; the optimization conditions for a curved slit chopper used in a time of flight device; and the calibration possibility of experimental data of differential partial cross-section measured with triple axis spectrometer experiments. (auth)

12129 THE EQUIPMENTS OF SOME EXPERIMENTAL CHANNELS OF THE RESEARCH REACTORS IN USSR. Demidov, A. M. (Inst. of Atomic Energy, Moscow). pp 405-26 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966. (In Russian).

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The equipment problems of some experimental channels of the scientific-research reactors in USSR are discussed. Data on neutron monochromators and polarizators, dosimeters, In–Ga loops and on the transport of radioactive substances used in USSR to carry out the work at the reactors are also presented. (auth)

12130 NEUTRON SPECTROMETRY WORK AT THE CNEN LABORATORIES OF ISPRA. Caglioti, G. (CCR–EURATOM, Ispra, Italy). pp 427-37 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The research programme of slow neutron spectrometry at a beam hole of the ISPRA-1 reactor, equipped with a crystal spectrometer, is presented and briefly discussed. The work includes: systematic studies of the experimental methods and techniques; and physics experiments on the structure and dynamical behavior of solids and liquids. (auth)

12131 SLOW NEUTRON SPECTROMETERS AT THE SWEDISH REACTORS. Dahlborg, U. (Aktiebolaget Atomenergi, Stockholm); Larsson, K. E.; Skoeld, K. pp 455-75 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

In Stockholm at the 600–kW heavy-water moderated reactor R1 two slow chopper time-of-flight spectrometers are in simultaneous operation. One of these uses a Be filter as monochromator, while the other one either a Be filter or a crystal monochromator may be used. Angular distribution measurements using the combination of a crystal monochromator and time-of-flight analysis have been found to give very valuable results even though the intensity as well as the resolution is relatively poor. The time-of-flight spectrometer in Studsvik at the 30–MW light-water moderated reactor R2 uses, for monochromatizing purposes, the combined action of a Be filter and a chopper with a narrow transmission curve. At this spectrometer, as well as at the one in Stockholm, the chopper is placed before the sample, thus offering the possibility of simultaneous recording of data at different angles of observation. At R2 a triple-axis crystal spectrometer is also in operation. Different properties of the different instruments, such as intensities, resolutions, as well as their suitability for certain measurements, are given. A comparison between the light- and heavy-water moderated reactors for beam tube work shows the distinct advantages of the heavy-water type. (auth)

12132 EXPERIMENTAL ARRANGEMENTS FOR THE MEASUREMENT OF NEUTRON CAPTURE RADIATION, IN PARTICULAR IN-PILE COMPONENTS. Schult, O. W. B.; von Egidy, T.; Gruber, U.; Bieber, E.; Maier, B. P.; Elze, T.; Koch, R. (Technische Hochschule, Munich. Atomic Energy Commission, Riso, Denmark). pp 477-85 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A DuMond type curved crystal spectrometer is in operation at one of the tangential facilities of the DR-3 reactor at Risø. Gamma transitions with energies between 20 keV and 1.3 MeV can be measured with this instrument, which permits a precision of 2×10^{-5} in absolute energy determination of intense lines around 100 keV. Very strong 200 keV lines can be resolved, even if their energies differ only by 70 eV, i.e., the resolution can be as good as 3.5×10^{-4} in optimal cases. The conversion-electron spectrometer, which is placed at the FRM reactor at Garching, uses an extended target in the vicinity of the reactor core. After passing a step collimation system, the electrons are doubly focused in a magnet, which combines a homogeneous and an inhomogeneous field and deflects the electrons by 90°. The resolution of this instrument is rather high and permits the separation of the three L-components of the 334 keV line from ^{166}Sm. (auth)

12133 NUCLEAR PHYSICS RESEARCH AT IRR-1. Ben-David, G. (Israel Atomic Energy Commission, Yavne). pp 487-91 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The main experiments of nuclear physics carried out at the reactor IRR-1 are described. Analyzed are the reactions (n,α) the fission experiments, the Mössbauer effect, and the beams of polarized neutrons. (auth)

12134 USE OF A FAST SOURCE REACTOR FOR LOW LEVEL IRRADIATION EXPERIMENTS. Farinelli, U. (CNEN, Rome). pp 493-500 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

The TAPIRO fast source reactor being designed at CNEN Casaccia, although mainly aimed at experiments connected with a fast reactor programme, will be used for several experiments in various fields requiring a "clean" fast neutron spectrum. The reactor itself is similar in principle to AFSR but includes some original features, like a Cu reflector, an incoherent concrete shield, and an instrumentation without period meters. The safety philosophy of this reactor is shortly reviewed, and some results of the hazard analysis are shown. This reactor proves to be a very safe machine, even for quasi-metropolitan areas. Neutron spectra in various irradiation facilities, and intensities at the nominal power of 1 kW, are shown; gamma contamination is evaluated. Preliminary examples of typical experiments foreseen for installation in the reactor are given, ranging from reactor physics to radiation damage, from shielding experiments to genetic studies. (auth)

12135 SAFETY ASPECTS OF IRRADIATION EXPERIMENTS. Merrett, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 507-23 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26–31, 1964. See CONF-791.

A review of safety criteria for irradiation experiments in DIDO and PLUTO reactors is presented. The method for evaluating safety characteristics of irradiation experiments according to categories is discussed. (D.C.C.)

12136 EXPERIENCE OUTSIDE THE PILE ON POWER EXCURSIONS. Elberg, S.; Nyer, M. (CEN, Grenoble, France). 63p. (In French). (CONF-660455–3(and Add.)). DTIE.

From Symposium on Heat Exchange During Transients, Cadarache, France.

A description of the heat transfer loop, CABRIOLE, is given. The loop was designed to study thermal effects caused by power excursions in swimming-pool reactors, of which CABRI is a typical example. The electrical heating systems, which simulate the thermal transients, are detailed. Methods of data recording, power dissipation measurements, and temperature and pressure measurements are outlined. Void measurements are detailed. Experimental results are shown graphically. (M.L.S.)

12137 CONTROL ROD. (to Commissariat a l'Energie Atomique). French Patent 1,403,767. May 17, 1965. Filed May 12, 1964.

The core of a swimming-pool type nuclear reactor consists of an assembly of individual fuel cells. Each fuel cell comprises a parallelepiped box made of a material which absorbs few neutrons and a series of parallel fuel plates disposed inside the box. Two neutron-absorbent plates, joined at their upper end by a stirrup, are capable of sliding parallel with the fuel plates into the box. A damping device, comprising a piston secured to the stirrup and a cylinder fixed to the box, is provided for retarding the neutron-absorbent plates at the end of their movement into the box. (IIB)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 10430, 10449, 10493, 10565, 10572, 10627, 10939, 10941, 10944, 11021, 11024, 11034, 11036, 11038, 11046, 11058, 11068, 11089, 11090, 11096, 11097, and 11101.

12138 (BNWL–472) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES. Quarterly Report, January–March 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1967. Contract AT(45-1)-1830. 116p. Dep. CFSTI.

Progress in various phases of work on the physics of reactors is reported in sections on reactor theory and code development, thermal reactors, fast reactors, critical mass physics, and neutron physics. Separate abstracts were prepared for each of the five sections. (H.D.R.)

For abstracts of individual sections see: 11872, 12085–12087, and 12139.

12139 (BNWL–472, pp 2.1-3) REACTOR THEORY AND CODE DEVELOPMENT. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Eighteen isotopes for which additional and more accurate data have been added to the BNW Master Cross Section Library are listed. An angular synthesis approximation method applied to analyzing a thin critical slab is outlined, and eigenvalues and

total fluxes are presented for several different thicknesses. (H.D.R.)

12140 (BNWL-CC-788) PROGRAM BETA: A REACTOR KINETICS CODE. Page, L. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 23, 1966. Contract AT(45-1)-1830. 52p. Dep. CFSTI.

A computer code, BETA, for extraction of delayed neutron parameters from experimental data is given. The program computes prompt neutron lifetime, delayed neutron fraction, and corresponding decay constants from a plot of least squares fitted flux vs. time after negative reactivity insertion. The program is written in FORTRAN. (M.L.S.)

12141 (GA-7544) APPROXIMATE METHOD FOR MULTIDIMENSIONAL DIFFUSION THEORY PROBLEM. Hansen, K. F.; Johnson, S. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 18, 1967. Contract AT(04-3)-167. 43p. Dep. CFSTI.

An approximate method for solving the multidimensional diffusion theory problem is presented. The method involves expanding the flux function by polynomial expansion in three-dimensions. Coupling of separate regions is made through leakage currents only. The spatial shapes of the leakage currents are then calculated analytically. The method of solution is detailed. The GORST computer program, which is a result of this theoretical work, is discussed. Input format, sample input, and program listing are given. (M.L.S.)

12142 (JEN-171-DF/I-51) METODOS DE CALCULO EN REACTORES NUCLEARES. (Methods for Nuclear Reactor Calculations). Velarde, G. (Junta de Energia Nuclear, Madrid (Spain). Division de Fisica). 1966. 24p. (In Spanish). Dep.

Methods for solving the neutron transport equation in reactors are determined. The mathematical techniques utilized are P_L, B_L, M_L, S_N and discrete ordinate approximations. Simplifications and assumptions are outlined. (M.L.S.)

12143 (WCAP-2873) SPACE DEPENDENT REACTOR TRANSFER FUNCTIONS. PART I. THEORY. Poncelet, C. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Mar. 1966. 51p. Dep. CFSTI.

A method is described for the calculation of the space-dependent reactor transfer function with feedback. It is shown that the equations for the space-dependent transfer function can be written in the form of non-homogeneous, time-independent, coupled diffusion-type equations. The method is readily applicable to multi-energy, multi-dimensional, multi-region problems, and can include arbitrary feedback mechanisms. (17 references). (auth)

12144 NEUTRON FILTERS FOR THERMAL OR COLD NEUTRON BEAMS. van Dingenen, W.; Hautecler, S. (SCK-CEN, Mol, Belg.). pp 357-76 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26-31, 1964. See CONF-791.

The transmission of polycrystalline filters for cold neutrons and of single crystal blanks for thermal neutrons has been measured at 293°K and at 77°K. For polycrystalline filters the filtering efficiency and the transmission for cold neutrons depends on the grain size. The best result is obtained with cast Be: at a preset transmission of 10^{-5} for thermal neutrons and of 10^{-4} for γ-rays, the transmission for cold neutrons has a value of 0.613. The effective transmission of single crystal blanks for thermal neutrons is found to be very sensitive to the product of the mosaic spread and the reflectivity of the crystal. The number of single crystal blocks, contained in the blank, is less important. In this respect, MgO (magnorite) seems to be a very promising material, owing to the perfectness of its crystals. Its other characteristics (density, Debye-temperature, free atom cross-section) are also reasonably good. (auth)

12145 A VERY FLEXIBLE PULSED BEAM SPECTROMETER FOR STUDYING NEUTRON SCATTERING IN SOLIDS AND LIQUIDS. Carvalho, F.; Ehret, G.; Glaeser, W.; Ripfel, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 441-53 of Research Reactor Experimental Techniques. Stefanescu, Alexandru (ed.). Bucharest, Editura Academiei Republicii Socialiste Romania, 1966.

From Study Group on Research Reactor Experimental Techniques, Bucharest, Oct. 26-31, 1964. See CONF-791.

A double spectrometer for slow neutrons consisting of a rotating crystal and set-ups for time-of-flight measurements working in a range of incident energies from 5 to 200 MeV is described. A comparison of the rotating crystal and the phased chopper technique is made. It is demonstrated that the rotating crystal spectrometer allows a very economic utilization of a reactor neutron beam. The tailoring of the monochromatic neutron beams is described. The possibilities of data handling with a small on-line digital computer are discussed. (auth)

12146 REACTIVITY INTEGRAL THEOREM. Stumbur, E. A. At. Energ. (USSR), 23: 255-7(1967). (In Russian).

The neutron flux distribution in a critical reactor without an external source may be determined by the stationary Boltzmann kinetic equation, assuming that the fission spectrum is isotropic and independent of the energy of the fissioning neutron. The reactivity coefficient K(r) is defined by means of the theory of small perturbations, designating the functional J as the reactivity integral of the total volume of the reactor: $J = \int K(r)\, dV$. For reactors which consist of separate homogeneous regions, the reactivity integral of the critical system is equal to the ordered sum of ΔK_i jumps of the reactivity coefficients at the surfaces of the homogeneous regions, including the external boundary of the reactor, multiplied by the volumes V_i bounded by these surfaces. In both of its general and partial forms, the theorem may be used to analyze various theoretical and experimental reactor problems. (TTT)

12147 BOLTZMANN INTEGRAL EQUATION TREATMENT OF NEUTRON RESONANCE ABSORPTION IN REACTOR LATTICES. Lewis, E. E. (Massachusetts Inst. of Tech., Cambridge); Adler, F. T. Nucl. Sci. Eng., 31: 117-26(1968).

A method has been developed for calculating resonance effects in nuclear reactor lattices without the two widely used assumptions: that the neutron flux is spatially independent within each region of the lattice cell; that the flux recovers an asymptotic 1/E form between resonances. The neutron slowing down problem is formulated in terms of a Boltzmann integral equation, and the correct transport kernel is derived for a Wigner-Seitz equivalent cell with isotropic scattering in the laboratory system. A new method of polynomial approximations is then used to reduce the transport problem to matrix form. The result is a set of integral equations in lethargy for the neutron flux at a number of discrete ordinates. These equations are numerically integrated to obtain the neutron flux as a function of position and energy. Resolved resonance integrals are calculated for a number of ^{238}U-graphite lattices with both metal and oxide rods. Where comparisons are made, the results are in excellent agreement with accurate Monte Carlo calculations. Both the flat flux and flux recovery assumptions are found to cause significant overestimates of the resonance integrals, the errors increasing with the rod radii. The temperature coefficients, however, are less sensitive to these assumptions. 18 references. (auth)

12148 IGNITION AND COMBUSTION OF REACTOR MATERIALS. Peterson, Sigfred. Nucl. Safety, 9: 10-14(Jan.-Feb. 1968).

Information on oxidation reactions that could occur in accidents in the nuclear industry are reviewed briefly, with emphasis on conditions for ignition and consequences of fire. Reports reviewed are concerned with metallic fuels, structural metals, alkali metals, graphite, and other materials. Significant new reports reveal increased concern with the ignition of charcoal off-gas adsorbers, experience with safe handling of liquid hydrogen, and study of ignition behavior of an increasing number of structural metals and alloys. 42 references. (auth)

12149 DETERMINATION OF THE $\alpha_0 = \beta/l^*$ PARAMETER FOR PUISATION OF THE JEN-2 REACTOR. Diez Moreno, J. E.; Martin Nuno, C.; Alcober, V.; Fajardo, M.; Montes, J. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 365-72(Nov.-Dec. 1967). (In Spanish).

The parameter $\alpha_0 = \beta/l^*$ corresponding to JEN-2 reactor has been determined by the pulsed source method. The measurements have been done pulsing the reactor in different negative reactivity conditions. The results are discussed in terms of pulsing rate, width of the neutron burst, etc. (auth)

12150 PROMISES AND DISADVANTAGES OF THORIUM, SECOND NATURAL NUCLEAR FUEL. Meriel, Yves. Sci. Progr.-Nature, No. 3390, 378-84(Oct. 1967). (In French).

The Th-^{233}U cycle is outlined; the disadvantages of the use of Th as a nuclear fuel are described. The nuclear and metallurgical behavior of Th, the number of neutrons produced per absorbed neutron, and the complexities of reprocessing are considered. The techniques used to eliminate the disadvantages and utilize the advantages of Th as a fuel are outlined. These include thermalization of neutrons, resonance zones, conversion rate, inventory, and use of combined cycles. The tested and advanced breeder reactors using Th are briefly indicated. (J.S.R.)

12151 SAMPLING APPARATUS CONTROLLED BY TELEVISION. (to Commissariat a l'Energie Atomique). French Patent 1,455,962. Sept. 12, 1966. Filed July 22, 1965.

The sampling apparatus is introduced into a reactor channel to obtain graphite samples of the graphite wall of the channel. The apparatus consists of a first part, containing a motor, a tool driven by the motor and a cylinder for receiving the samples, and a second part articulated with the first part and carrying a television camera oriented towards the tool. The second part is fixed to rigid connection shafts to adjust the position of the attacking tool with precision. The tool is applied firmly against the wall during sampling by an elastic device controlled from the exterior of the channel. (IIB)

12152 PRESSURE VESSEL FOR NUCLEAR REACTOR. (to Compagnie Industrielle de Travaux). French Patent 1,428,553. Jan. 10, 1966. Filed Jan. 4, 1965.

The reactor core is disposed in a prestressed concrete cylindrical vessel. The cover is applied under pressure on the cylindrical shell by means of tensioned bars extending axially through channels in the concrete. The cylindrical shell is prestressed by means of cables encircling the shell. The internal concrete structure is covered with a gas-tight liner. (IIB)

12153 NUCLEAR REACTOR CONTROL APPARATUS. Lebey, J.; Costes, D. (to Commissariat a l'Energie Atomique). Canadian Patent 761,076. June 13, 1967. Priority date July 27, 1962, France.

Rapid shutdown of a nuclear rocket is achieved by pouring neutron absorbing material of grain or shot size into the core. A reservoir above a vertical channel into the core holds the shot until required. A valve actuated by pressure differences in fuel element channel and the reservoir is opened when shutdown is necessary. A device employing a hydraulic ram is provided for removing the shot when normal operation is to be resumed. (F.S.A.)

12154 COMPLIANT FLANGE VESSEL CLOSURE. Rudock, Eugene R. (to United States Atomic Energy Commission). U. S. Patent 3,362,567. Jan. 9, 1968.

A flexible bellows seal for a nuclear reactor cover in which a first bellows is attached to the cover and a second bellows is attached to the pressure vessel. The free end of each bellows is provided with an annular ring so that when the cover is in place, the two annular rings mate and form a seal with the two bellows in compression. (AEC)

12155 SHUTTER DEVICE FOR NUCLEAR REACTOR CORE. Dutta, Keshab; Hawke, Basil G. (to United States Atomic Energy Commission). U. S. Patent 3,361,637. Jan. 2, 1968.

An apparatus for regulating the flow of a fluid coolant through different regions of a reactor core is described. The apparatus comprises a shutter device including a pair of elements relatively rotatable and containing openings which can be moved into and out of registration. (AEC)

12156 GAS-COOLED NUCLEAR REACTOR. Trickett, Kenneth A.; Simnad, M. T.; Malek, George J. (to United States Atomic Energy Commission). U. S. Patent 3,366,549. Jan. 30, 1968.

An improved fuel element for a high-temperature gas-cooled nuclear reactor featuring an elongated annular sleeve having a plurality of elongated fuel pins supported longitudinally proximate thereto in clustered fashion is described. All is surrounded by an array of beryllia blocks so as to define an annular passage for conducting coolant against the pins. Each pin comprises an outer tubular refracting shell, enveloping particles of nuclear fuel dispersed in a beryllia matrix. Enhanced removability of fuel without disturbing moderator and increased volumetric heat transfer are advantageously afforded. (AEC)

12157 DEVICE FOR INTRODUCTION OF OBJECTS IN A LEAK-TIGHT VESSEL AND FOR THE WITHDRAWAL OF OBJECTS FROM SAID VESSEL, ESPECIALLY INTENDED FOR THE REFUELLING FACILITY OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). French Patent 1,359,751. Mar. 23, 1964. Filed Feb. 28, 1963.

The device is employed for the purpose of transferring fuel element magazines between a servicing chamber and the exterior of the reactor. The device consists of the first and second transfer means each including a support trolley and a turntable which are movable within a tunnel so as to effect the transfer of fuel elements between a station which is in communication with the reactor vessel and a transit compartment. Other transfer means are movable within another tunnel and effect the transfer of fuel elements between the transit compartment and another station which is in communication with the exterior of the reactor vessel. Sealing members are disposed between the transfer means and the tunnel so as to separate the transit compartment from the reactor vessel when the transfer means are in the position in which the fuel elements are located within the compartment. (IIB)

GENERAL

12158 (BNWL-480, pp 107-26) MOLECULAR AND CELLULAR LEVEL STUDIES. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Progress is reported on studies of: the control of RNA metabolism in Escherichia coli, tryptophan synthesis and transport in Neurospora crassa; and sterol synthesis in yeasts. (E.R.B.)

12159 (BNWL-572(Vol.1)) THE MOUNTAIN IRON DIFFUSION PROGRAM: PHASE I. SOUTH VANDENBERG: VOLUME I. Hinds, W. T.; Nickola, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 220p. (AFWTR-TR-67-1). Dep. CFSTI.

Field diffusion experiments were conducted at Vandenberg Air Force Base, California, during 1965 and 1966. This program, nicknamed "Mountain Iron," was undertaken to establish quantitative diffusion predictions for use as range safety tools in the "South Vandenberg" ballistic and space vehicle operations. The only pollutant source character studied was toxic propellant materials released continuously from ground level pools. The operational applications and limitations of the equations and other results obtained are described. (auth)

12160 (CALT-642-3) STUDIES IN DEVELOPMENTAL IMMUNOGENETICS. Progress Report, July 29, 1966-July 27, 1967. Owen, Ray D.; Sanders, Bob G. (California Inst. of Tech., Pasadena. Div. of Biology). July 27, 1967. Contract AT(04-3)-642. 10p. Dep. CFSTI.

Progress is reported on studies of developmental immunogenetics in various species of vertebrates with emphasis on the characteristics of polypeptide chains. Data are included from electrophoretic studies of polypeptides of myeloma proteins; the electrophoretic homogenicity of polypeptide chains from gamma G immunoglobulins; the comparative serology of polypeptide chains from gamma G immunoglobulins of 15 animal species; polypeptide map analysis and determinations of amino acid composition of gamma G heavy and light polypeptide chains of various species; the analysis of polypeptide map studies of gamma G heavy chain carbohydrate peptide from 15 animal species; the site of antibody stabilization of bacteriophages; the effects of gamma G, gamma H, and gamma M immune globulins on adsorption of the T2H bacteriophage to the bacterial host; the effects of injected antigen fragments on the retention of foreign tissues grafts on animals; the antigenic analysis of cultured mouse cells; and studies on anti-Rh antibodies isolated from human serum. (C.H.)

12161 (COO-582-14) FINAL REPORT [ON NUCLEATION OF DIMETHYLGLYOXIMES]. Thompson, Stephen; Walton, Alan G. (Case-Western Reserve Univ., Cleveland, Ohio). Sept. 1, 1967. Contract AT(11-1)-582. 62p. Dep. CFSTI.

Processes of nucleation are discussed. The nucleation and growth of nickel dimethylglyoximate, nickel cyclohexanedioximate, and palladium dimethylglyoximate were studied. Interfacial energies were calculated. Experimental details of the system utilized to produce and observe precipitation of nickel dimethylglyoximate in very small droplets are described. Crystal structures of nickel and palladium derivatives of a whole series of dialkyldioximes were studied by electron microscopy. (M.C.G.)

12162 (COO-614-57) ICR QUARTERLY REPORT NUMBER 14. Yngve, Victor H. (Chicago Univ., Ill. Inst. for Computer Research). Aug. 1, 1967. Contract AT(11-1)-614. 39p. Dep. CFSTI.

Developments in Maniac III engineering activity and the Man-Machine project are outlined. An investigation of a graph stimulator computer is described. Also, a bench mark calculation for retrieval by confluence of binary attributes in a random-access computer is considered, and numerical stability in n-body integrations is discussed. (W.H.K.)

12163 (COO-1265-45) FLEXIBLE RESIDENT SYSTEM FOR THE SMALL 3100. Goodwin, Robert W.; Hobbie, Russell K. (Minnesota Univ., Minneapolis. School of Physics). [nd]. Contract AT(11-1)-1265. 27p. (CONF-670442-1). DTIE.

From 12th Semi-Annual Swap Conference, San Francisco, Calif.

The BASIC FORTRAN and Basic Assembler systems provided for an 8K-3100 lack many features, such as an over-all operating system, and I/O flexibility and compatibility. On the other hand, the SCOPE operating system can be too general and cumbersome for the user who does not require automatic stacked job processing with a minimum of operator interaction. A RESIDENT operating system is described which processes control statements from any unit and provides flexible I/O handling and unit assignments patterned after SCOPE Central I/O. Multiple programs can be loaded and called independently. The complete system occupies about 5000 (octal) words of memory, including the trapped floating point routines. (auth)

12164 (COO-1265-46) IMPROVEMENTS TO THE BASIC ASSEMBLER. Goodwin, Robert W.; Hobbie, Russell K. (Minnesota Univ., Minneapolis. School of Physics). [nd]. Contract AT(11-1)-1265. 7p. (CONF-670442-2). DTIE.

From 12th Semi-Annual Swap Conference, San Francisco, Calif.

The original Basic Assembler was efficient for a small machine, but it lacked certain features which are available in Compass. Eight-character address tags are now allowed. Options of a symbol cross-reference table and an intermediate source tape are now available. A feature not found in Compass, which has proved useful in modifying basic FORTRAN, allows the use of arbitrary operation-code mnemonics. All of these improvements are discussed. (auth)

12165 (COO-1265-47) IMPROVEMENTS TO BASIC FORTRAN-II. Goodwin, Robert W.; Hobbie, Russell K. (Minnesota Univ., Minneapolis. School of Physics). [nd]. Contract AT(11-1)-1265. 8p. (CONF-670442-3). DTIE.

From 12th Semi-Annual Swap Conference, San Francisco, Calif.

The original BASIC FORTRAN has several shortcomings. I/O units are fixed at the time of installation. The compiler is difficult to modify, since it cannot be assembled by the user. Output is compatible only with the special FORTRAN loader, and only one program can be in core at a time. The compiler was repunched as a Compass-type source deck using shortened address tags. The new compiler retains the object program in core until compilation is complete and then puts it out in standard relocatable form. The run-time package has been eliminated by providing either in-line coding or specific subroutines. Several other features have been added. Currently the compiler occupies 10400_8 words and requires source input, listable output and object output media. (auth)

12166 (COO-1469-0033) QUARTERLY TECHNICAL PROGRESS REPORT, JANUARY-MARCH 1966. (Illinois Univ., Urbana. Dept. of Computer Science). 203p. (COO-1018-1091). Dep. CFSTI.

Developments in the circuit research program, hardware and software systems research, numerical methods, computer arithmetic, and artificial languages are outlined. The service, use, and program development for ILLIAC III and a discussion of the pattern recognition computer ILLIAC III are given. Also, research problem specifications and general laboratory information are presented. (W.H.K.)

12167 (COO-1469-0045) QUARTERLY TECHNICAL PROGRESS REPORT, APRIL-JUNE 1966. (Illinois Univ., Urbana. Dept. of Computer Science). 175p. Dep. CFSTI.

Developments in the circuit research program, hardware system research, software and time-sharing systems research and numerical methods, computer arithmetic, and artificial languages are presented. Also ILLIAC II service, use, and program development, IBM service, use and program development, problem specifications, and general laboratory information are outlined. (W.H.K.)

12168 (KAPL-M-7026) REFLECTION OF GASEOUS DETONATION WAVES. Martin, F. J. (General Electric Co., Schenectady, N. Y. Research and Development Center). Dec. 1967. 40p. (67-C-480). Dep. CFSTI.

For Knolls Atomic Power Lab., Schenectady, N. Y.

For the design of pressure vessels to contain explosive gas mixtures in which detonation may occur, it is desired to be able to estimate the pressure-time trace and the impulse following reflection of the detonation at a rigid wall. It is shown that bounds on these quantities can be calculated from known properties of the detonation wave and the flow field behind it, when certain arbitrary conditions are imposed on the reflected shock and the flow behind it. The bounds are shown to be consistent with over-all momentum requirements. The pressure behind the reflected wave is shown to fall off inversely with time to the power n where $2 < n \leq 3$. Time is measured from the point of initiation of detonation. The equations for the calculations are given together with a computer program written in BASIC language. (auth)

12169 (LA-3807) WIREX, A FORTRAN COMPUTER PROGRAM FOR PRODUCING WIRE LISTS. Duerre, K. H.; Case, J. R. (Los Alamos Scientific Lab., N. Mex.). Sept. 18, 1967. Contract W-7405-eng-36. 38p. Dep. CFSTI.

WIREX is an IBM 7090 computer program that produces wiring lists containing all the information normally found on detailed wiring drawings. Input to WIREX is simple, and output is in the form of a job book containing information in the order in which it is required for an electrician to proceed logically through a wiring job. Code listings, flow diagrams, and a sample problem are included in this report. (auth)

12170 (LA-3827) SCIENTIFIC ADVENTURING AND MISADVENTURES. Shipman, Thomas L.; Reider, Roy (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

12171 (NVO-99-19) STRUCTURAL RESPONSE OBSERVATIONS: PARKFIELD, CALIFORNIA EARTHQUAKE, JUNE 27, 1966. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Sept. 1967. 71p. CFSTI.

An earthquake on June 27, 1966, caused minor damage in Shandon, Cholame, Parkfield and Paso Robles, in South Central California. The main shock was calculated by various seismological observatories to have been of magnitude 5.3 to 6.5. The epicenter was calculated to be about 8 km northwest of Parkfield, with a hypocenter at a depth of about 5 km (ESSA 1966). Intensity in the Parkfield–Cholame was rated at VII on the modified Mercalli scale. Surface breakage along the San Andreas fault in the earthquake area extended about 21 miles. Structural damage was largely confined to broken glass, cracks in masonry and plaster, collapsed brick chimneys, cracked swimming pools, road bridge slabs shifted at abutments, cracks in highway pavements, fallen bric-a-brac, and displaced wooden structures. Estimated total damage cost was about $125,000.00. The main shock was felt over an area of about 20,000 square miles. Sixteen strong motion stations in the vicinity were instrumented with U. S. Coast Geodetic Survey seismoscopes and Stations 2, 5, 8 and 12 were equipped with UED Model AR-240 accelerographs. Peak accelerations recorded on the accelerographs were near 0.50g (gravity units), a remarkably high acceleration value for a relatively small earthquake. Structures in the area are predominantly older rural buildings, constructed without regard to building code requirements. A relationship between ground acceleration and structural effects along the array of four strong motion stations west of the surface breakage is shown. (auth)

12172 (NVO-1163-115) ENVIRONMENTAL RESEARCH CORPORATION PROCEDURE FOR NC-21 INSTRUMENT CORRECTION. Watson, D. L. (Environmental Research Corp., Alexandria, Va.). June 30, 1967. Contract AT(29-2)-1163. 51p. CFSTI.

This report describes the Environmental Research Corporation (ERC) procedure for obtaining the corrected velocity and scale factors from the uncorrected velocity data obtained from U. S. Coast and Geodetic Survey. The uncorrected data are received in the form of analog magnetic tape, and the corrected data output is in the form of paper records and magnetic tape. The purpose is to clearly define this procedure in order to assist users of the data in evaluating any results that they may obtain. (auth)

12173 (NYO-3621-5) NUCLEAR METABOLISM OF DNA AND RNA AND THE SITES OF RADIATION SENSITIVITY. Progress Report, 1966–1967. Abrams, Richard (Pittsburgh Univ., Pa. Dept. of Biochemistry and Nutrition). July 15, 1967. Contract AT(30-1)-3621. 11p. Dep. CFSTI.

Progress is reported on the following studies: metabolism of rapidly labeled nuclear RNA in Ehrlich ascites cell nuclei; characterization of a nuclear phosphodiesterase and studies on its role in nuclear RNA turnover; DNA synthesis in animal cells; and investigation of the use of plant cells for clarifying pathways of RNA metabolism. (H.L.W.)

12174 (NYO-3675-4) RELATED SPECTRAL AND STRUCTURAL STUDIES. Progress Report. Gentile, Philip S. (Fordham Univ., New York. Dept. of Chemistry). Dec. 15, 1967. Contract AT(30-1)-3675. 35p. Dep. CFSTI.

Progress is reported on the isolation of nine cis- or trans-bis(halogenoacetato)-triethylenetetramine cobalt (III) complexes; the wealth of accompanying spectral data for comparison with ammine and ethylenediamine analogs that were previously isolated; the isolation of six pairs of the α and β isomers of trien Co(III) complexes; the isolation of dicyano and diisocyano trien Co(III) complexes; and the virtual completion of the structure of a trans-dicyano trien complex. Work with structural determinations, molecular orbital calculations, magnetic susceptibility, and solid–solid interactions is also reported. (D.H.M.)

12175 (NYO-3827-3) ANNUAL PROGRESS REPORT [ON NUCLEIC ACID METABOLISM IN RAT ANTERIOR PITUITARY GLANDS], MARCH 1, 1967–FEBRUARY 29, 1968. Hymer, Wesley C. (Pennsylvania State Univ., University Park). Contract AT(30-1)-3827. 15p. Dep. CFSTI.

The research outlined in this progress report was carried out to determine the mode of action of hypothalamic releaser substances on pituitary cells in organ culture. The results to date indicate that these substances do not activate transcription. However these extracts will, under certain specific conditions, cause an increase in the rate of protein synthesis as well as an increase in the rate of oxidative metabolism in pituitaries in organ culture. Taken together, these data imply that the cytoplasm of pituitary cells offer possible sites of action for the releaser substances. Also included are data that show that DNA synthesis occurs in pituitary tissue. The significance of this finding is under current investigation. (auth)

12176 (ORNL-4208) INFORMATION THEORY IN SEQUENTIAL ANALYSIS. Tittle, Roger Lee (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 53p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The information as defined in a sequential test S of simple hypotheses, which is determined by cumulative sums of independent and identically distributed random variables and which terminates with probability 1, is investigated. The Wald sequential probability ratio test is given particular emphasis as a special case of the general test S. In the case of a sequential probability ratio test, it is demonstrated that information $I(a) = I(c)$ whenever the sequential probability ratio test of hypotheses $g_i(u)$, $i = 1, 2$, belong to an important class of density functions, namely the exponential family. All of the primary results stated previously are obtained for the case in which all the random variables under consideration admit a Borel measurable density function; however, by interpreting integrals as sums, and replacing Lebesque measure by the counting measure, the results remain valid for the discrete case as well. (auth)

12177 (ORNL-TM-2018) CALCOMP PLOTTING OF X-RAY POLE FIGURES. Love, Gordon R. (Oak Ridge National Lab., Tenn.). Jan. 1968. Contract W-7405-eng-26. 39p. Dep. CFSTI.

A FORTRAN 63 program, POLE, used with the CDC 1604 computer is described which converts x-ray intensity data from a serial string of numerical values to a contour map, in stereographic projection, with intensity as a function of angular coordinates relative to the specimen. (W.H.K.)

12178 (ORO-2840-6) DIELECTRIC RELAXATION IN CHLOROFORM AND IN THE BINARY DIPOLAR MIXTURE: BENZONITRILE + ACETONITRILE. Gopalan, T. V.; Boshers, H. A.; Kadaba, P. K. (Kentucky Univ., Lexington. Dept. of Electrical Engineering). Dec. 13, 1967. Contract AT(40-1)-2840. 13p. Dep. CFSTI.

Mixtures of simple rigid polar molecules (acetonitrile and benzonitrile) were studied at microwave frequencies near room temperature. The dielectric relaxation of chloroform was also investigated. Results on the dipolar mixtures were analyzed in terms of two relaxation times τ_1 and τ_2 corresponding to the two polar components. There is good evidence to indicate that in the dielectric relaxation of mixtures studied, each species exhibits its own dispersion although it might be modified according to the concentration and nature of the second component. For chloroform in n-heptane the relaxation time tended in increase with increasing dilution. Data are presented in tables and graphs. (M.C.G.)

12179 (ORO-2858-19) STABLE ISOTOPE TRACER STUDIES. Final Progress Report, June 1, 1967–September 15, 1967. Gordon, Gilbert (Maryland Univ., College Park. Dept. of Chemistry). Dec. 22, 1967. Contract AT(40-1)-2858. 6p. Dep. CFSTI.

Studies were concluded on the reaction between tris(1,10-phenanthroline)iron(II) and chlorate ions, chlorine dioxide, chlorite ion, hypochlorous acid, and chlorine in aqueous solution. Experiments carried out to show that complexes of 1,10-phenanthroline with iron can be used as a tool to discern whether oxidants undergo one- or multi-electron changes are described. (M.C.G.)

12180 (ORO-3348-2) CHROMOSOME STRUCTURE AND THE EVOLUTION OF GENOME NON-HOMOLOGY. Annual Progress Report, December 1, 1966–November 30, 1967. Menzel, Margaret Y. (Florida State Univ., Tallahassee. Dept. of Biological Science). Dec. 1, 1967. Contract AT(40-1)-3348. 6p. Dep. CFSTI.

CHROMOSOMES—fine structure of, at various meiotic stages in tomato

ANGIOSPERMIDAE—Hibiscus sp., genome relations in hybrids of; Hibiscus sp., homology at chromosomes and DNA in; Haplopappus gracilis, karyotype changes in long-term callus cultures of, effects of grafting and media supplements on

CHLOROPHYTA—Chlamydomonas reinhardi, life cycle of, tritium-labeled thymidine tracer study of (E.R.B.)

12181 (ORO-3542-2) CHEMISTRY OF RUTHENIUM COMPLEXES. Annual Report. Mercer, E. E. South Carolina Univ., Columbia). Jan. 1968. Contract AT(40-1)-3542. 34p. Dep. CFSTI.

The kinetics of ligand-substitution reactions of nitrosylruthenium were studied. A calorimetric study was made of the heats of formation of Ru(VI) and Ru(VIII) species. The chemistry of Ru(II) and Ru(III) in aqueous solutions is discussed. Periodate complexes of ruthenium were studied. (M.C.G.)

12182 (PPAD-634-D) PRECISION DIGITAL TO ANALOG CONVERTER. Sanders, H. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). Oct. 10, 1967. Contract AT(30-1)-2137. 7p. Dep. CFSTI.

A 14 bit binary coded digital to analog converter has been designed to meet the requirements of the PATR system. The D to A converter steps the position of a cathode ray tube spot from which it is continuously varied by a ramp-type sweep. To achieve the system requirements for overall stability and accuracy an attempt has been made to design the converter with a maximum error of 20 parts per million over a ±3°C temperature range. Test results indicate a stability of better than six parts per million per day and a temperature coefficient of about three parts per million per degree centigrade. (auth)

12183 (SC-CR-67-2509) THIN FILM GAUGING MACHINE FEASIBILITY STUDY. Final Report. Faust, Paul L. (Data Corp., Dayton, Ohio. Applied Research Dept.). May 1967. Contracts AT(29-1)-789; 29-9368. 46p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The results of a feasibility study for a high-precision, noncontacting optical profilometer which is intended primarily to measure precision thin-film circuit elements are presented. It was desired that the system resolve vertical measurements within 0.8 microinch and lateral positions within 40 microinches. The fiduciary was a light spot 40 microinches in diameter. The merits of manual, semiautomatic and automatic systems are outlined. Resolving and servo schemes are discussed. (auth)

12184 (SC-CR-67-2825) AN ELECTRON BEAM SCANNING SYSTEM FOR MEASURING DIELECTRIC PROPERTIES. Final Report. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 15p. Dep. CFSTI.

An electron beam scanning system for measuring conduction, capacitance, and field reversal voltage for ferroelectric ceramics is described. The results of preliminary measurements on materials with high dielectric constants are discussed. (W.H.K.)

12185 (SC-CR-67-2841) RESIDUE ANALYSIS OF THERMALLY DECOMPOSED ISOCYANATOPENTAMMINE COBALT(III) PERCHLORATE. Technical Report No. II. Chun, B. D.; Olson, F. A. (Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Sept. 30, 1967. Contract AT(29-1)-789; Subcontract No. 58-1099. 32p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Analyses of (isothiocyanatopentammine)cobalt(III) perchlorate (ICCP) and solid ICCP decomposition products as a function of the stage of decomposition using x-ray, infrared, and wet chemical methods indicates several consecutive reactions. The principal intermediate solid species for decomposition in open air is NH_4ClO_4, with other minor intermediates being $Co(HCO_3)$, Co_4S_3, Co_3O_4, $CoCl_2$, $CoSO_4$, $HClO_4$, and NH_4Cl. The principal final residue is Co_3O_4. In a vacuum the decomposition mechanism differs from that in open air; some of the open-air decomposition steps apparently do not exist and initial ICCP is extant for a considerably greater fraction of the decomposition. However, it was found that the final decomposition product was mainly Co_3O_4 but NH_4ClO_4 was present to a greater extent as an end product. Based on these residue analyses and other studies fourteen possible equations of reactions are postulated. However, the principal reactions were initial ICCP decomposition with NH_3 gas as a principal product and decomposition of the intermediate NH_4ClO_4 to gaseous products. (auth)

12186 (SC-CR-67-2842) STUDY OF DECOMPOSITION KINETICS OF SELECTED SECONDARY EXPLOSIVES. (Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Sept. 15, 1967. Contract AT(29-1)-789; Subcontract No. 58-1099. 42p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The decrease in surface area of hexanitroazobenzene (HNAB) at various temperatures in the range 50 to 200°C was found to be dependent upon the logarithm of time. Also over a period of several months HNAB showed a decrease of about 30% in surface area at ambient conditions. Based upon electron micrographs the area decrease seems to be due to a decrease in surface roughness and voids and not due to sintering of major particles. Decomposition of isothiocyanatopentammine cobalt III perchlorate (ICCP) was studied using thermogravimetric kinetic measurements, gas phase analysis and pressure rise kinetic measurements, and residue analysis. Decomposition followed a geometric model regardless of whether open air, continuous vacuum, initial vacuum or continuous gas flow was used. With this model the reaction starts at selected active centers (observed optically with ICCP) and progresses outward at a constant rate to completion leading to sigmoidal curves of the fraction reacted versus time. With ICCP this was complicated by curves in open air having two distinct sigmoidal curves indicating two major consecutive reactions. The first reaction was shown to be initial decomposition of ICCP with a principal intermediate product NH_4ClO_4 (plus cobalt compounds) which then decomposed leaving a final principal residue of $Co_3O_4 \cdot H_2O$. The activation enthalpy of the first major reaction was 29 Kcal/mole and of the second major reaction 25 Kcal/mole. Decomposition under continuous vacuum eliminated side reactions giving one sigmoidal curve and causing a marked increase in the activation enthalpy to 52 Kcal/mole, indicating a less favorable reaction route to the same final product. The first step in the decomposition of ICCP was loss of ammine groups; hence, NH_3 markedly retarded reaction to the extent that increasing the sample size above 1 mg reduced the thermogravimetric rate and in a relatively small closed system the NH_3 allowed only 13% reaction. Water vapor was found to also completely inhibit the second major reaction but had little or no effect on the initial decomposition. Other gases such as N_2, O_2, CO_2 and He had minor effects as compared to NH_3 and H_2O. Based upon the results a possible mechanism consisting of 14 separate reactions is postulated. (auth)

12187 (SC-DC-68-1995) HUMAN FACTORS ENGINEERING. Swain, A. D. (Sandia Corp., Albuquerque, N. Mex.). Dec. 26, 1967. Contract AT(29-1)-789. 17p.

Human errors are related to the design of the work situation rather than being related to human mistakes. Consequently, the most practical approach to improvement of human performance generally is to improve the work situation rather than trying to improve the human. Most error-likely situations can be recognized in the design stages of equipment and can be eliminated or satisfactorily controlled by application of human factors technology. Because Human Factors Engineering (HFE) emphasizes the design of systems of men and machines which takes the capabilities and limitations of both into account, HFE is best done in association with equipment designers, procedures writers, systems analysts, and reliability specialists. Generally the best design solution is one that neither overburdens the human nor overburdens the machine. (R.C.K.)

12188 (SC-DR-65-262) CHARACTERISTICS AND DEVELOPMENT REPORT FOR THE LJT CONNECTORS. Work, Ralph (Sandia Corp., Albuquerque, N. Mex.). June 1965. Contract AT(29-1)-789. 13p. Dep. CFSTI.

The construction and performance of the LJT series of connectors which were designed to reduce bent pin incidences during mating are described. A brief record of the development history and the problems encountered during development is also included. (auth)

12189 (SCL-DR-67-116) INFLUENCE OF CAPACITOR BANK PARAMETERS ON MAGNETICALLY DRIVEN FLYER PLATES. Nelson, D. B. (Sandia Corp., Livermore, Calif.). Dec. 1967. Contract AT(29-1)-789. 14p. Dep. CFSTI.

The effect of varying capacitor bank parameters on the performance of magnetically driven flyer plates is described. The equations relating magnetic impulse to bank parameters are derived and some typical curves presented. It is shown that the slow, high-energy bank, though less efficient, is capable of producing equally sharp and ultimately greater impulses than the fast, low-energy bank. (auth)

12190 (SC-M-67-2939) USE OF PRODUCT IDENTIFICATION AS A TRAINING AID FOR ANALYTICAL CHEMISTS. Grillo, J. P. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1968. 21p. Dep. CFSTI.

An analysis scheme for identification of commercial products and an approach to the schemes already available so that staff assistants may be trained to approach the analysis of an unknown are presented. The analysis process consists of gathering initial observations, listing tentative components, and analysis. Sample problems and a work sheet are included. (M.C.G.)

12191 (SC-R-67-1099) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Aug. 15, 1967. Contract AT(29-1)-789. 23p. Dep. CFSTI.

A bibliography is presented which contains 66 references to published literature on environmental engineering. (F.S.)

12192 (SC-R-67-1100) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Sept. 15, 1967. Contract AT(29-1)-789. 23p. Dep. CFSTI.

A bibliography is presented which contains 65 references to published literature on environmental engineering. (F.S.)

12193 (SC-R-67-1101) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Oct. 15, 1967. Contract AT(29-1)-789. 18p. Dep. CFSTI.

A bibliography is presented which contains 60 references to published literature on environmental engineering. (L.C.L.)

12194 (SC-R-67-1270) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Nov. 15, 1967. Contract AT(29-1)-789. 18p. Dep. CFSTI.

A bibliography is presented which contains 60 references to published literature on environmental engineering. (L.C.L.)

12195 (SC-RR-67-886) POISSON APPROXIMATION TO THE BINOMIAL AS A RELATION BETWEEN THE PERCENT POINTS OF THE BETA AND GAMMA DISTRIBUTIONS. Steck, George P. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 14p. Dep. CFSTI.

Let X be a binomial random variable with parameters n and p, let Y be a Poisson random variable with parameter θ, and let the quantities n, p, θ, and k be so related that $P(X > k) = P(Y > k)$. The first few terms of the following series are derived:

$$n = \frac{\theta}{w} + \frac{k}{2} + \frac{kw}{24\theta}(k + \theta + 2) + w^3 C(k,\theta) + \ldots$$

$$n = \frac{\theta}{w} + \frac{k}{w}\log\frac{\alpha}{w} + \frac{D_1(k,w)}{\theta} + \frac{D_2(k,w)}{\theta^2} + \ldots$$

$$\theta = wA - w^2\frac{A(N-A)}{k+2} + w^3 E(n,k) + \ldots$$

$$\theta = nw - k\log\frac{\alpha}{w} + \frac{F_1(k,w)}{n} + \frac{F_2(k,w)}{n^2} + \ldots$$

$$w = \frac{\theta}{N} + \frac{k\theta}{24}(k + \theta + 2) + \frac{G(k,\theta)}{N^3} + \ldots$$

$$w = \frac{\theta}{A} + \left(\frac{N-A}{k+2}\right)\left(\frac{\theta}{A}\right)^2 + \theta^3 H(n,k) + \ldots,$$

where $N = n - k/2$, $w = -\log_e(1-p)$ $\alpha = p/(1-p)$, A^{k+1} $n(n-1)\ldots(n-k)$. In the course of the derivations it is shown that $nw - k \le \theta \le nw - k\log\alpha/w$. Furthermore, extensive calculations suggest that $wA - w^2A/k + 2(N-A) \le \theta \le wA$. (auth)

12196 (TID-24213) EDITING COMPILERS, THEIR FEASIBILITY, AND EFFECTS. Report No. 209. Hassler, Edwin Bernard Jr. (Illinois Univ., Urbana. Dept. of Computer Science). Sept. 1, 1966. Contract AT(11-1)-1469. 105p. Dep. CFSTI.

Thesis.

The feasibility of an editing compiler, based on experience in writing the CLIC compiler at the University of Illinois and an examination of the implementation of FORTRAN II, FORTRAN IV, and ALGOL 60 as editing compilers, is discussed. An editing compiler is compared in terms of machine time and space with a compiler which is identical except that it is lacking those features devoted exclusively to editing. (W.H.K.)

12197 (TID-24225) QUARTERLY TECHNICAL PROGRESS REPORT, JULY-SEPTEMBER 1966. (Illinois Univ., Urbana. Dept. of Computer Science). 158p. Dep. CFSTI.

Developments in computer science are reported. Progress in the circuit research program, hardware and software systems research, library automation, numerical methods, computer arithmetic, and artificial languages are discussed. The service, use, and program development of ILLIAC II and IBM computers are summarized. Also, problem specifications, switching theory and logical design, and general laboratory information are outlined. (W.H.K.)

12198 (UCRL-13226) COMPUTER SIMULATION OF A HIGH SPEED TENSION TEST. Shippy, David J.; Gillis, Peter P. (Kentucky Univ., Lexington. Dept. of Engineering Mechanics); Hoge, Kenneth G. (California Univ., Livermore. Lawrence Radiation Lab.). [1967]. Contract W-7405-eng-48. 27p. (CONF-670329-1). Dep. CFSTI.

From 6th International Symposium on High Speed Testing, Boston, Mass.

In order to gain insight into the vibrational response of a load cell coupling a tensile specimen and a high speed testing machine a relatively simple mass-spring system was studied. The machine and load cell are represented by linear springs and the specimen by a nonlinear spring that closely models the static stress-strain behavior of many metals. These are connected in series with two masses representing the testing machine and the load cell-specimen combination. It is assumed that during a test the ends of this mass-spring series separate at a constant velocity. Numerical analysis of the system was carried out on a digital computer using values considered appropriate for such tests. Since the system has two degrees of freedom two vibrational modes were observed corresponding approximately to the natural frequencies of the machine and load cell. Vibrational amplitudes were usually of the same order of magnitude in the two modes. While the study was designed primarily to investigate the effects of specimen characteristics on load cell response, the most interesting result was that the period of the low frequency vibrational mode will usually be long compared with the time required for the specimen to fracture. This implies that the high frequency vibrations can have a mean value displaced in a given direction (by superposition on the low frequency mode) from the specimen force during the entire test. (auth)

12199 (UCRL-13326) TIME DOMAIN SYNTHESIS OF FINITE MEMORY DIGITAL FILTERS USING ORTHOGONAL POLYNOMIALS. Information Systems Simulation Laboratory Report 2. Brubaker, T. A.; Peterson, J. B. (Missouri Univ., Columbia). Oct. 1967. Contracts W-7405-eng-48; 8700503. 8p. Dep. CFSTI.

For Univ. of California, Lawrence Radiation Lab., Livermore.

Filtering is the process of transforming data from an experiment or process into a form which is more acceptable for analysis by a computer and/or a person. In the past, most filtering has been accomplished by use of analog devices; however, the increasing speed and decreasing size and cost of digital components now permits the economical use of digital filters to perform many desired filtering operations. A method for time domain synthesis of finite memory digital filters using orthogonal polynomials is presented. The use of orthogonal polynomials permits filter coefficients to be determined without any matrix inversion so that the method is well suited for on-line real time design using a digital computer. (auth)

12200 (UCRL-17853) BEHAVIOR OF SOME TRANSITION METAL PORPHYRINS. Phillips, Linda Kanner (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 133p. Dep. CFSTI.

Thesis.

In order to study the influence of porphyrin-type ligands on the chemistry of transition metal ions, the behavior of manganese in chelates with phthalocyanine, methyl pheophorbide-a, and etioporphyrin I, members of three distinct classes of porphyrins was investigated. Oxidation and reduction reactions of the methyl pheophorbide-a and etioporphyrin complexes were studied both in solutions and in the solid state. The compounds are light sensitive: the chelated manganese(III) is reduced to manganese(II) under irradiation by white light. (Methyl pheophorbide-a)manganese(IV) was produced. Its reduction was studied to learn whether this reaction can serve as a model for the role of manganese in photosynthetic oxygen evolution. However, no formation of free oxygen was detected. Adducts with pyridine, acetic acid, water, and other vapors were studied using a quartz helix microbalance designed so that atmosphere and temperature could be controlled. One pyridine per manganese was strongly bound and another weakly adsorbed by μ-oxobis (phthalocyaninomanganese), in agreement with the structure of this compound, which was determined by Vogt and co-workers (Vogt, Zalkin and Templeton, Science, 151, 569 (1966)). Similarly, etioporphyrin I acetotatomanganese(III), with a single vacant axial coordination position, forms 1:1 adducts with pyridine, acetic acid, or acetone. Phthalocyaninomanganese(II) adds two equivalents of pyridine, in a reaction whose rate depends on the history of the sample. The electron paramagnetic resonance of phthalocyaninomanganese(II), the only easily prepared manganese(II) compound among those studied, was investigated in glasses at 90°K. The manganese appears to be in its rare low-spin state ($S = \frac{1}{2}$) and shows anisotropic hyperfine and spectroscopic splitting tensors: $A = 151 \times 10^{-4}$, $B = 25 \times 10^{-4}$ cm^{-1}; $g_{\parallel} = 1.90$, $g_{\perp} = 2.16$. The unpaired electron is probably in the d_{xy} orbital of manganese. The energy ordering of levels is believed to be d_{xz}, $d_{yz} < d_{z^2} < d_{x^2-y^2}$. (auth)

12201 (UCRL-17936) STUDIES ON THE DICYANAMIDE MEDIATED SYNTHESIS OF DIPEPTIDES. Platt, Steven Gary (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 29p. Dep. CFSTI.

Thesis.

An attempt to repeat the earlier research that showed DCA dicyanamide to be an effective mediator of glycine condensation was not successful, that is, the earlier glycine work was not reproduced. Several possible explanations are given for the dis-

crepancy. A procedure was developed, after extensive theoretical and experimental investigations, that will allow for the answering of the research question on relative yields of 4 dipeptides in a DCA-mediated condensation reaction. That procedure is based upon the use of high-voltage paper electrophoresis and paper chromatography. It allows for the separation, and quantitative yield measurement, of the dipeptide reaction products of DCA mediated condensation occurring in a model system initially containing equal concentrations of two amino acids. The procedure was tested with the phenylalanine-glycine system, and found to successfully separate the four possible dipeptide products. Semi-quantitative information concerning the yields of dipeptide were obtained for the DCA mediated condensation of the amino acids valine, leucine, and phenylalanine. (M.C.G.)

12202 (UCRL-17966) TEMPERATURE DEPENDENT PROPERTIES OF DINUCLEOSIDE PHOSPHATES. Davis, Robert Charles (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1967. Contract W-7405-eng-48. 284p. Dep. CFSTI. Thesis.

The temperature dependent properties of dinucleoside phosphates were studied to obtain information about single-strand nearest neighbor interactions in ribonucleic acids. Optical rotatory dispersion, ultraviolet absorption, and proton magnetic resonance were used to probe the thermal disordering of these compounds. Two models were used to analyze the data. For the two-state model, a molecule was considered to be in either the ordered or disordered form with no permissible conformations between them. For the oscillating dimer model, the two bases of a dinucleoside phosphate were constrained by a single torsional harmonic potential. The properties of dinucleoside phosphates in dilute salt solutions (from 0°C to 90°C) were compatible with either model. Calculations of the potential energies of conformations of nucleic acid fragments were also carried out. Molecules were considered to consist of rigid sections (e.g., a base) connected by single covalent bonds about which rotation could take place. Interatomic potentials included charge-charge, charge-polarizability, polarizability-polarizability, and steric repulsion terms. These calculations indicated that pyrimidine nucleosides are all in the anti conformation while purine nucleosides may be either syn or anti. Energetically stable torsional angles calculated for larger systems generally agreed with those found in polynucleotide fiber structures. (222 references.) (C.H.)

12203 (USC-113-P-4-9) AQUEOUS CHEMISTRY OF FREE RADICALS AND OTHER INORGANIC REACTIVE INTERMEDIATES. Progress Report. Wilmarth, Wayne K. (University of Southern California, Los Angeles). [1967]. Contract AT(11-1)-113. 28p. Dep. CFSTI.

Kinetic studies were made of the one-electron reduction of a superoxide complex of cobalt by OH^- in alkaline solution. Certain preparative reactions are also summarized. Preliminary attempts were made to assign the structures of the binuclear complexes on the basis of a comparison of their infrared and NMR spectra with those of the mononuclear compounds. Cyanide complexes of the lower oxidation states of Re are being studied. Analytical procedures for Re determination in these complexes are described. Attempts were made to prepare $Na_3Re(CN)_5OH_2$ and $K_3Re(CN)_6$. The chemistry of $Re(CN)_6^{-5}$ was studied. (M.C.G.)

12204 (Y-1601) DETERMINATION OF LITHIUM IN LITHIUM ALUMINATE. Dietrich, W. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Jan. 18, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

A method was developed for determining the amount of lithium in the ceramic, lithium aluminate, and in other lithium compounds. Lithium is separated from any impurities by the cation exchange resin, Dowex 50-16X, and determined gravimetrically as the sulfate salt. The average recovery for lithium was 99.89% and the LE_x (0.95) was ±0.65%. An interim flame photometric procedure that was established prior to the development of the ion exchange-gravimetric method is also discussed. (auth)

12205 (ANL-Trans-545) INVESTIGATIONS ON THE PERCEPTION OF THE GRAVITY STIMULUS. Rutten-Pekelharing, C. J. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Rec. Trav. Bot. Neer., 7: 241-344(1910). 79p. Dep. CFSTI. JCL $7.60 fs, $2.30 mf.

The perception of stimuli by plants resulting in phototropic and geotropic responses is directly affected by the duration and intensity of these stimuli. This hypothesis was experimentally investigated using Avena coleoptiles subjected to gravitational and centrifugal forces and light stimuli of varying intensities and durations. The results indicate that the perception of these stimuli is predicated on the position of the coleoptile at a given intensity for a given duration of the stimuli. The results of the investigation may be summarized as follows: the product of the effective force and the presentation time is constant for gravity and centrifugal stimulations for the same plant under the same conditions; the perception of the gravity stimulus is not equal to that of the light stimulus; and roots from which the starch was removed can still react geotropically even though damage is evident. A bibliography of the early investigations in this area is included. (E.R.B.)

12206 (LA-tr-68-1) FRACTIONATION, STRUCTURE AND POSSIBLE BIOLOGICAL FUNCTION OF HISTONES. Schwenke, Klaus Dieter. Translated from Z. Chem., 7: 91-101(1967), 29p. Dep. CFSTI.

Histones are DNA-bound proteins that occur mainly in the nuclei of somatic cells of higher animals and in plant tissues. The fractionation of histones following their isolation from neoplastic tissue is reported. The conformation of histones and the histone-DNA complex and their probable functions in the cell are discussed. Function was concluded to be of a regulatory nature with regards to pathological changes. The importance of the function of the histones is stressed in the light of the unregulated growth of cancer tissues. (E.R.B.)

12207 (ORNL-tr-1824) THEORETICAL AND EXPERIMENTAL STUDY OF STRUCTURES SUBJECTED TO EARTHQUAKES. Soubirou, A. Translated for Oak Ridge National Lab., Tenn., from Ann. Ponts Chaussees, 137: 77-158(1967). 63p. Dep. CFSTI. JCL $6.60 fs, $2.09 mf.

The behavior of structures subjected to earthquakes was investigated. Seismic movements are described and analyzed. Useful concepts for earthquake-proofing structures are introduced. The dynamic behavior of systems with "n" degrees of freedom was studied in order to evolve the theoretical computation of seismic behavior, a typical application being reticulated structures. The computational procedure for seismic spectra and natural frequencies of buildings is shown, and an attempt is made to define earthquake-proofing criteria for a special type of reinforced-concrete construction. The elastoplastic behavior of structures, a study of increasingly growing importance, is considered. (auth)

12208 (SC-T-67-0956) ON THE FORM ASSUMED BY THE MOVEMENT EQUATIONS OF FLUIDS WHEN TAKING INTO ACCOUNT THE CAPILLARY FORCES CAUSED BY VARIATIONS OF DENSITY WHICH ARE CONSIDERABLE BUT CONTINUOUS, AND ON THE THEORY OF CAPILLARITY IN THE HYPOTHESIS OF A CONTINUOUS VARIATION OF DENSITY. Korteweg, D. J. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Arch. Neer. Sci. Exactes Natur., (2), 6: 1-24(1901). 28p. Dep. CFSTI. JCL $2.60 fs, $1.04 mf.

12209 (UCRL-Trans-10163) EFFECTS OF A CEMENT RING ON THE RESISTANCE OF CASINGS AGAINST COLLAPSE. Vladimirov, K. A.; Gayvoronskiy, A. A.; Yuzbashev, G. S.; Baykov, A. M.; Shanovich, L. P.; Logvinov, I. I.; Il'in, N. G.; Safiullin, M. N. Translated by J. Mulhaus for Univ. of California Lawrence Radiation Lab., Livermore, from Neft. Khoz., 6: 19-24 (1964). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Experiments were performed to determine qualitatively and quantitatively the effect of a cement ring on the bearing capacity of casing strings. The experiments confirmed the theoretical calculations. It was found that wall thickness can be reduced for cemented sections of the strings. More tests are needed to make it possible to adopt more accurate methods for designing well linings to save metal. (F.S.)

12210 (UCRL-Trans-10188) TECHNICAL PROJECT OF BLAST FOR THE CONSTRUCTION OF THE BOYPAZY DAM ON THE RIVER VAKHSH. Agareva, E. N. Translated by T. Lazar for Univ. of California Lawrence Radiation Lab., Livermore, from Tr. Sess. Uch. Sov. Narodnokhoz. Ispol'z. Vzryva, 5th, Frunze, Kirg. SSR, 1963, 254-8(1965). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Cost analysis, explosion plans, and expected results from a project to create a reservoir for irrigating the Yavanskaya and Obi-Kikskaya valleys are discussed. Two charges of explosives located on the right bank of the Vakhsh River on either side of the dam axis are to be used to blast out dense stratified limestone from the steep right bank of the river to form a closed rock-filled dam 55 m high. (F.S.)

12211 (UCRL-Trans-10190) METHOD OF NUMERICAL INTEGRATION OF THE DIFFUSION EQUATION. Saul'ev, V. K. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 115: 1077-9 (1957). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

12212 (UCRL-Trans-10191) NUMERICAL INTEGRATION OF PARABOLIC EQUATIONS. Saul'ev, V. K. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 117: 36-9(1957). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

12213 (UCRL-Trans-10192) METHODS OF IMPROVED ACCURACY AND OF APPROXIMATIONS FROM ABOVE AND BELOW TO SOLUTIONS OF PARABOLIC EQUATIONS. Saul'ev, V. K. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 118: 1088-90(1958). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

12214 (UCRL-Trans-10198) A NEW METHOD FOR THE MEASUREMENT OF VERY LOW VAPOR PRESSURES. THE VAPOR PRESSURES OF MERCURY AND OF POTASSIUM. PART III. Mayer, H. Translated by F. D. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Z. Phys., 67: 240-63 (1931). 41p. Dep. CFSTI. JCL $4.60 fs, $1.43 mf.

A new method was developed for the measurement of very low vapor pressures (10^{-1}–10^{-2} mm Hg). The principles of the method are discussed and checked experimentally. The applicability of the method was checked and confirmed by measurement of the vapor pressures of mercury, which are well known from other measurements. The vapor pressures of potassium were measured between 69.8°C (vapor pressure 2.0×10^{-6} mm Hg) and 143.2°C (vapor pressure 4.78×10^{-4} mm Hg). The results are represented by the formula $\log p.T = -(21087/4.571 \times T) + 10.418$ which differs only slightly from a formula previously reported. Comparison of the vapor pressures obtained by the author with values obtained by other observers in the same temperature range or in adjoining ranges shows good agreement with some reported values, whereas other reported values are about 20 to 30% lower. (auth)

12215 (UCRL-Trans-10201) INDUSTRIAL TECHNOLOGY OF THE ANTIMONY-CESIUM PHOTOEMISSIVE LAYER. Marandas, G. Translated by G. Watson for Univ. of California Lawrence Radiation Lab., Livermore, from a French Thesis. 102p. Dep. CFSTI. JCL $9.10 fs, $3.29 mf.

The formation of Sb–Cs layers as photocathodes for photomultiplier tubes is studied in order to develop technical standards for reproducible production. The Sb and Cs sources are examined from the standpoints of quality and quantity, and conditions are established for forming $SbCs_3$ with maximum sensitivity. Resulting photocathode properties and effects on photomultiplier tube behavior are described. (D.L.C.)

12216 RECENT DEVELOPMENTS IN THE AREA OF PLASMA MOTORS. Peters, Th. (Institut fuer Plasmadynamik, Stuttgart). Luftfahrttech.-Raumfahrttech., 13: 53-7 (Mar. 1967).

A short review of different patterns of development in electric motors for space vehicles is given; then the area of continually working plasma motors is treated. The electrothermal motor, in which only arc heating is used, is discussed first, then new ideas of the past 3 years in magnetically accelerated continually working plasma motors are outlined. These use not only the magnetic self field of the arc but also the Hall currents achieved with external magnetic fields for acceleration. Both techniques are described from the observations made in work at the Institut fuer Plasmadynamik. Correlations of velocities achieved with Ar in external fields are graphed, and data for several working engines are tabulated for Ar, He, and H_2 as working gases. (BBB)

12217 URANIUM ENRICHMENT SERVICES CRITERIA AND RELATED MATTERS. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION, AUGUST 2, 3, 4, 16, AND 17, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 538p. GPO $1.75.

URANIUM—enrichment services criteria for; procurement and reserves of
REACTOR FUELS—raw material procurement and fabrication of
ISOTOPES—separation facilities for
PLUTONIUM—production of
GASEOUS DIFFUSION PLANTS—operation of
ATOMIC ENERGY, LEGAL ASPECTS—AEC authorizing legislation, fiscal year 1968
ECONOMICS—costs of nuclear fuels (L.C.L.)

12218 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1965. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-EIGHTH CONGRESS, SECOND SESSION ON RAW MATERIALS, SPECIAL NUCLEAR MATERIALS, AND WEAPONS PROGRAMS, JANUARY 22, 23, 27, FEBRUARY 3, 4, AND 7, 1964. Washington, D. C., Joint Committee on Atomic Energy, 1964. 301p. GPO $1.00.

ISOTOPES—production and uses in US
REACTORS—development programs for
REACTOR FUELS—raw materials procurement for
NUCLEAR WEAPONS—development programs for
URANIUM ORES—procurement programs for
ATOMIC ENERGY, LEGAL ASPECTS—AEC authorizing legislation, fiscal year 1965 (L.C.L.)

12219 AEC AUTHORIZING LEGISLATION, FISCAL YEAR 1966. PART 1. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION ON GENERAL; RAW MATERIALS; SPECIAL NUCLEAR MATERIALS; NUCLEAR WEAPONS PROGRAM; CIVILIAN APPLICATION OF NUCLEAR EXPLOSIVES (PLOWSHARE); ISOTOPES DEVELOPMENT; BIOLOGY AND MEDICINE; COMMUNITIES; CONSTRUCTION PLANNING AND DESIGN; SECURITY INVESTIGATIONS; PROGRAM DIRECTION AND ADMINISTRATION; TRAINING; EDUCATION, AND INFORMATION; AND PHYSICAL RESEARCH PROGRAMS, JANUARY 27, FEBRUARY 2, 3, 4, 10, 16, AND MARCH 10, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 815p. GPO $2.25.

NUCLEAR WEAPONS—development programs for
ECONOMICS—cost of USAEC programs
REACTORS, POWER—development programs for
HIGH-ENERGY PHYSICS, METALLURGY, MEDICINE, BIOLOGY—research programs in
ISOTOPES—production and uses of
COMPUTERS—research programs on
PLOWSHARE PROJECT—development and operation of
REACTOR FUELS—raw material procurement for
NUCLEAR EXPLOSIONS, UNDERGROUND—detection and uses of
ATOMIC ENERGY, LEGAL ASPECTS—AEC authorizing legislation, fiscal year 1966 (L.C.L.)

12220 PROCEEDINGS OF THE IOWA ACADEMY OF SCIENCE FOR 1965. VOLUME 72. THE SEVENTY-SIXTH SESSION, HELD AT DUBUQUE, APRIL 23-24, 1965. McNabb, Harold S. Jr. (ed.). Des Moines, Iowa, The State of Iowa, 1967. 544p. (CONF-650461).

Seventy-one papers are presented. Topics covered are arranged under the following fields: botany, chemistry, conservation, geology, psychology, science teaching, and zoology. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of the individual paper see: 10195.

12221 PROCEEDINGS OF THE COMMERCIAL FISH FARMING CONFERENCE, TEXAS A AND M UNIVERSITY, COLLEGE STATION, TEXAS, FEBRUARY 1–2, 1967. College Station, Tex., Texas A and M University, 1967. 66p. (CONF-670208). DTIE.

A separate abstract was prepared for one paper on the value of freshwater fish as a protein source in postattack environments. Ten other papers dealing with various aspects of commercial fish farming are included. (H.L.W.)